TM 9-1530

WAR DEPARTMENT



# TECHNICAL MANUAL

# ORDNANCE MAINTENANCE

# AIMING CIRCLES, M1, M1918 (FRENCH), M1916, AND M1916MI

August 19, 1941

TECHNICAL MANUAL
No. 9–1530

WAR DEPARTMENT,
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ORDNANCE MAINTENANCE

# AIMING CIRCLES, M1, M1918 (FRENCH), M1916, AND M1916MI

Prepared under direction of the
Chief of Ordnance



402879°—41——1

## SECTION I

## GENERAL



**1. Purpose.**—This manual is published primarily for the information and guidance of ordnance maintenance personnel.

**2. Scope.**—This manual supplements the Technical Manuals which are prepared for the using arm. It contains descriptive matter and illustrations sufficient to provide a general working knowledge of the equipment and detailed instructions for inspection, maintenance, and repair by ordnance maintenance personnel. Figures which accompany the text show the placement and method of fastening of each of the component parts of the equipment.

**3. References.**—The appendix lists all Standard Nomenclature Lists and other publications for the matériel described herein.

## SECTION II

## AIMING CIRCLE, M1



**4. Description.**—The aiming circle, M1 (fig. 1), is an instrument for use in measuring angles in azimuth and site and for general topographic work. This instrument complete consists of the aiming circle, tripod, M5, carrying case, M6A1, and instrument light, M2.

*a. Aiming circle, M1.*—The major components of the aiming circle, M1, are the telescope assembly and elevating screw mechanism, declinator, azimuth mechanism, and orienting mechanism.

(1) The telescope assembly (figs. 4 and 5) is used for direct observation of angles in elevation and azimuth within the field of view and for accurate training on an object as required in the determination of larger angles.

(*a*) The telescope is of the prismatic type. It is provided with an eyepiece focusing sleeve.

(*b*) The eyepiece reticle, B129648 (fig. 5), is inscribed with a vertical mil scale and a horizontal mil scale. Each mil scale is graduated in 5-mil intervals 85 mils each side of the point of intersection.

(*c*) The telescope level vial, A31332, is affixed to the telescope body. When the bubble in the level is centered, the optical axis of the telescope is horizontal, and the angle of site of an object within the field of view is indicated directly on the vertical mil scale of the reticle.

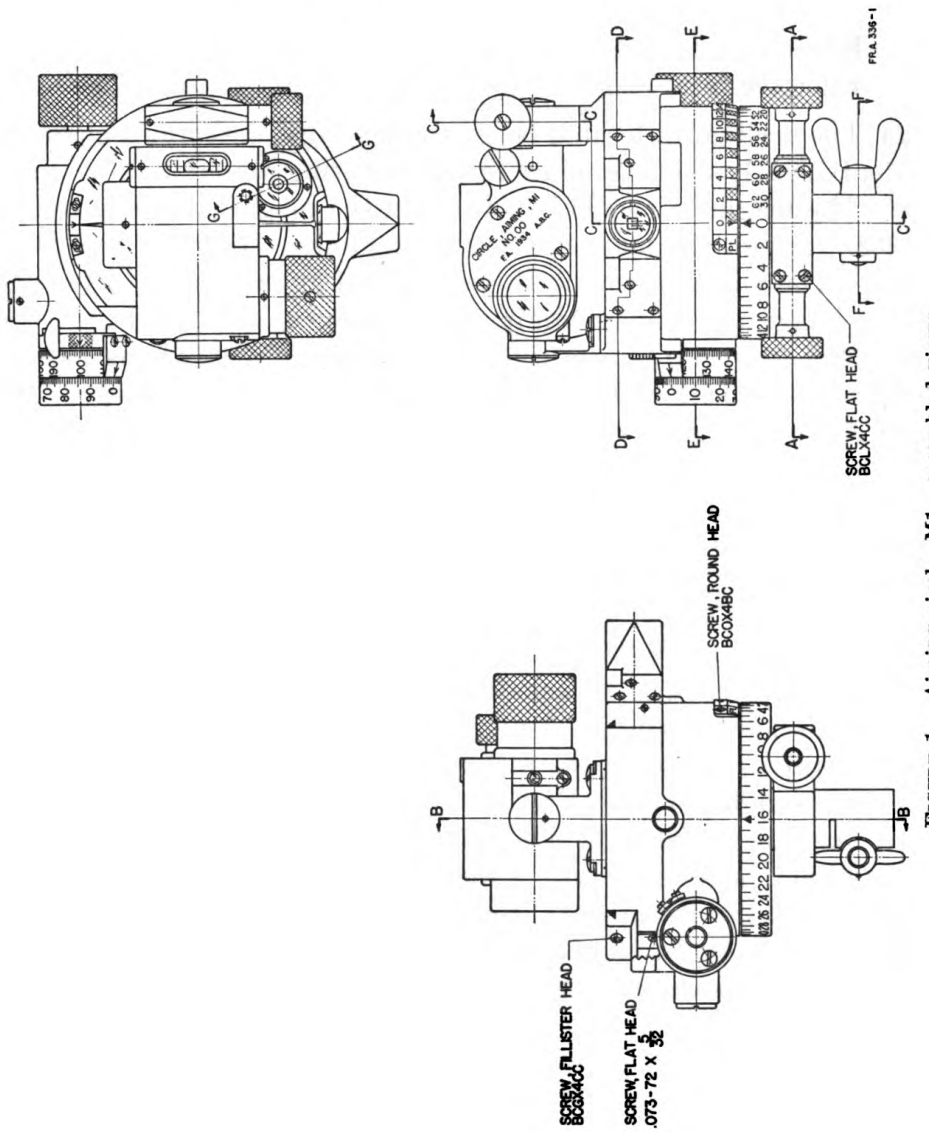



FIGURE 1.—Aiming circle, M1—assembled views.

(*d*) The elevating screw mechanism is housed in the upright portion of the aiming circle body, D28553, which incloses and supports the telescope body trunnion, B129644. By rotating the elevating screw knob, A39593, the telescope assembly can be rotated in the vertical plane approximately 8° above or below the horizontal.

(*e*) The optical characteristics of the telescope assembly are as follows:

| | |
|---|---|
| Power | 4X |
| Field of view | 10° |
| Diameter of exit pupil | .156 inch |
| Effective focal length of objective | 3.135 inches |
| Effective focal length of eyepiece | .784 inch |

(2) The declinator, located below the telescope, contains a magnetic needle, B129647, which provides initial orienting direction.

(*a*) The magnetic needle is viewed on the magnetic needle reticle, A39633, through the magnetic needle magnifier, B135660 (sec. D–D, fig. 3). The image of the north-seeking end appears as a knife edge, and the image of the south-seeking end appears as a rectangle.

(*b*) The magnetic needle releasing plunger, A39632A, is painted olive drab; the locking plunger, A39632B, is painted vermilion.

(*c*) A circular level vial, A39668 (fig. 2), is provided for leveling the aiming circle.

(3) The azimuth mechanism moves the telescope assembly and declinator in azimuth. The azimuth direction is indicated in mils by means of a scale and micrometer.

(*a*) The main azimuth scale is engraved on the exposed periphery of the worm gear, C44750. The circumference of the main azimuth scale is graduated into 64 equal spaces, each representing 100 mils. The main scale has engraved indexes at 0, 16, 32, and 48 which are used in conjunction with the plateau scale for computation of firing data for the sight, M1901 (French).

(*b*) Angles between 3200 and 6400 mils may also be read on an auxiliary azimuth scale which is engraved on the exposed periphery of the worm gear directly below the graduations of the main azimuth scale. This auxiliary azimuth scale is graduated into 32 equal spaces each representing 100 mils, numbered from 0 to 32 in a clockwise direction, and located so that the 0 graduation coincides with the 32 graduation on the main azimuth scale. The scale is for use in reciprocal laying of guns equipped with panoramic telescopes which are graduated 0–3200, 0–3200.

(*c*) The azimuth plateau scale, B135656, is attached to the body of the aiming circle, and consists of a quadrant graduated into eight equal divisions, each representing an angle of 200 mils and numbered from 0 to 16. Each division is halved and the alternate 100-mil spaces thus formed are cross-hatched for reference to the

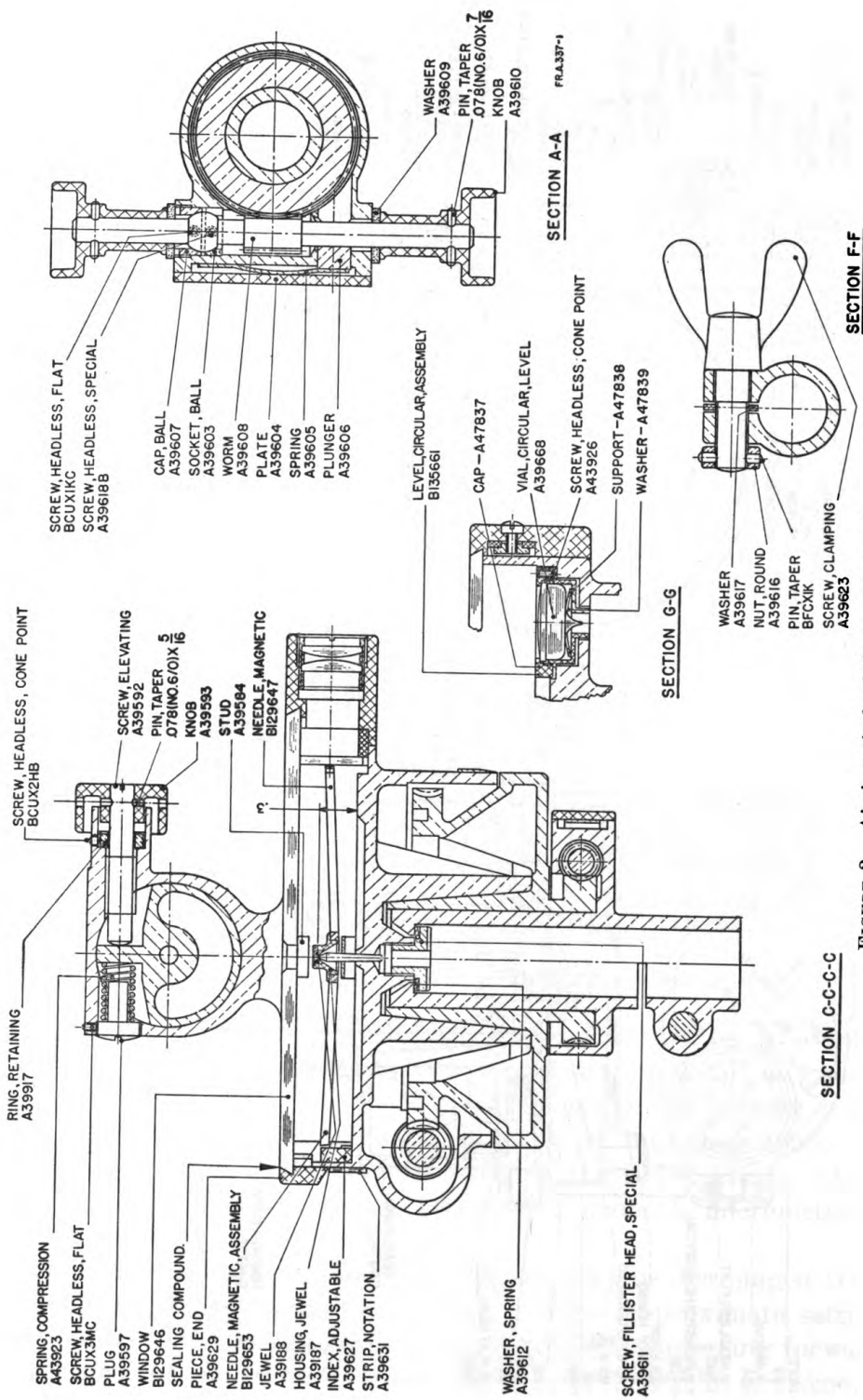



FIGURE 2.—Aiming circle, M1—sectioned views.

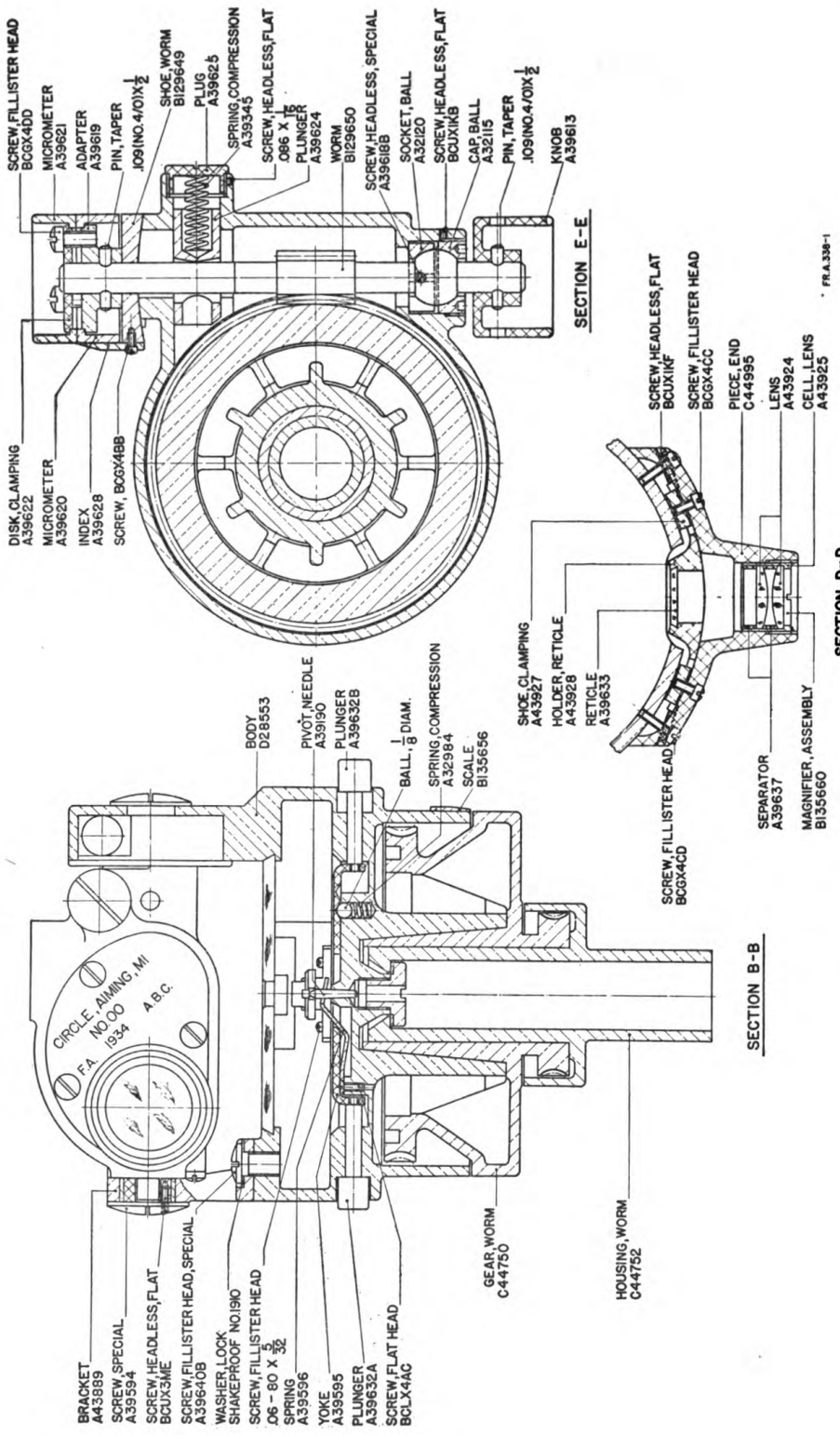



FIGURE 3.—Aiming circle, M1—sectioned views.

plateau azimuth micrometer. The arrow line which is engraved on this scale is the azimuth index.

(*d*) The azimuth micrometer, A39621, and plateau azimuth micrometer, A39620, are assembled to the azimuth worm, B129650, and actuated by the azimuth worm knob, A39613, to rotate through a complete revolution as the azimuth index is advanced through an angle of 100 mils.

*1.* The azimuth micrometer, A39621 (fig. 3), is graduated into 100 equal spaces, each representing 1 mil and numbered from 0 to 100.

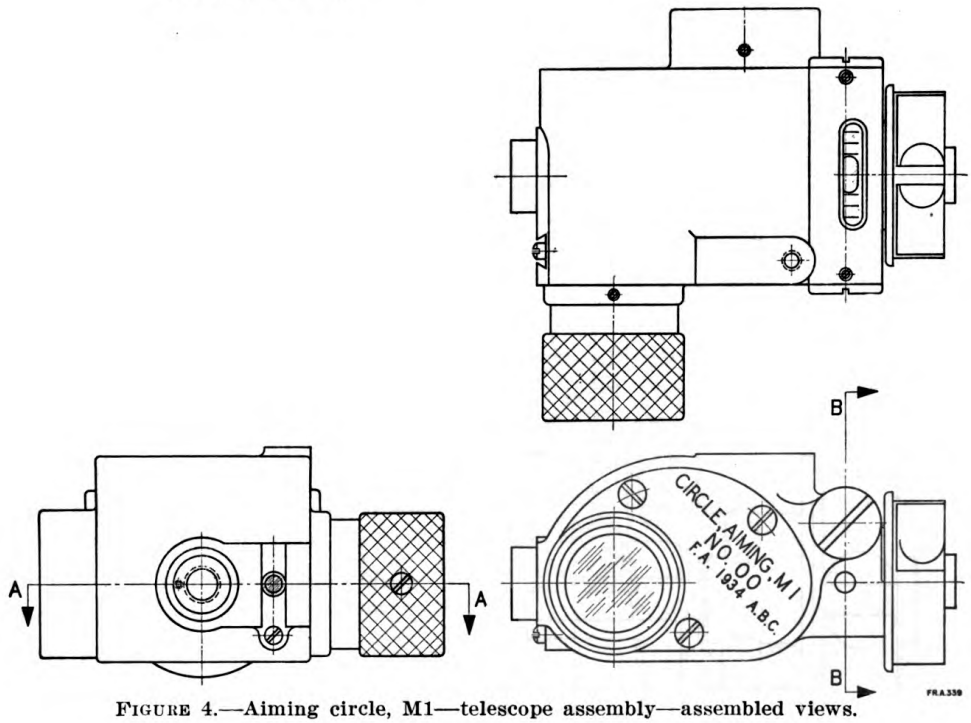



FIGURE 4.—Aiming circle, M1—telescope assembly—assembled views.

*2.* The plateau azimuth micrometer, A39620, is graduated into 100 equal spaces, each representing 1 mil and numbered from 100 to 200. When using the plateau scale, if an index at 0, 16, 32, or 48 points into clear space, the azimuth micrometer is read; if the index points into a cross-hatched space, the plateau azimuth micrometer is read.

(*e*) The azimuth worm, B129650 (fig. 3), may be disengaged from the teeth of the worm gear to permit a rapid approximate setting in azimuth. The disengagement is accomplished by pressing forward on the grip of the azimuth worm shoe, B129649, at the micrometer end of the worm.

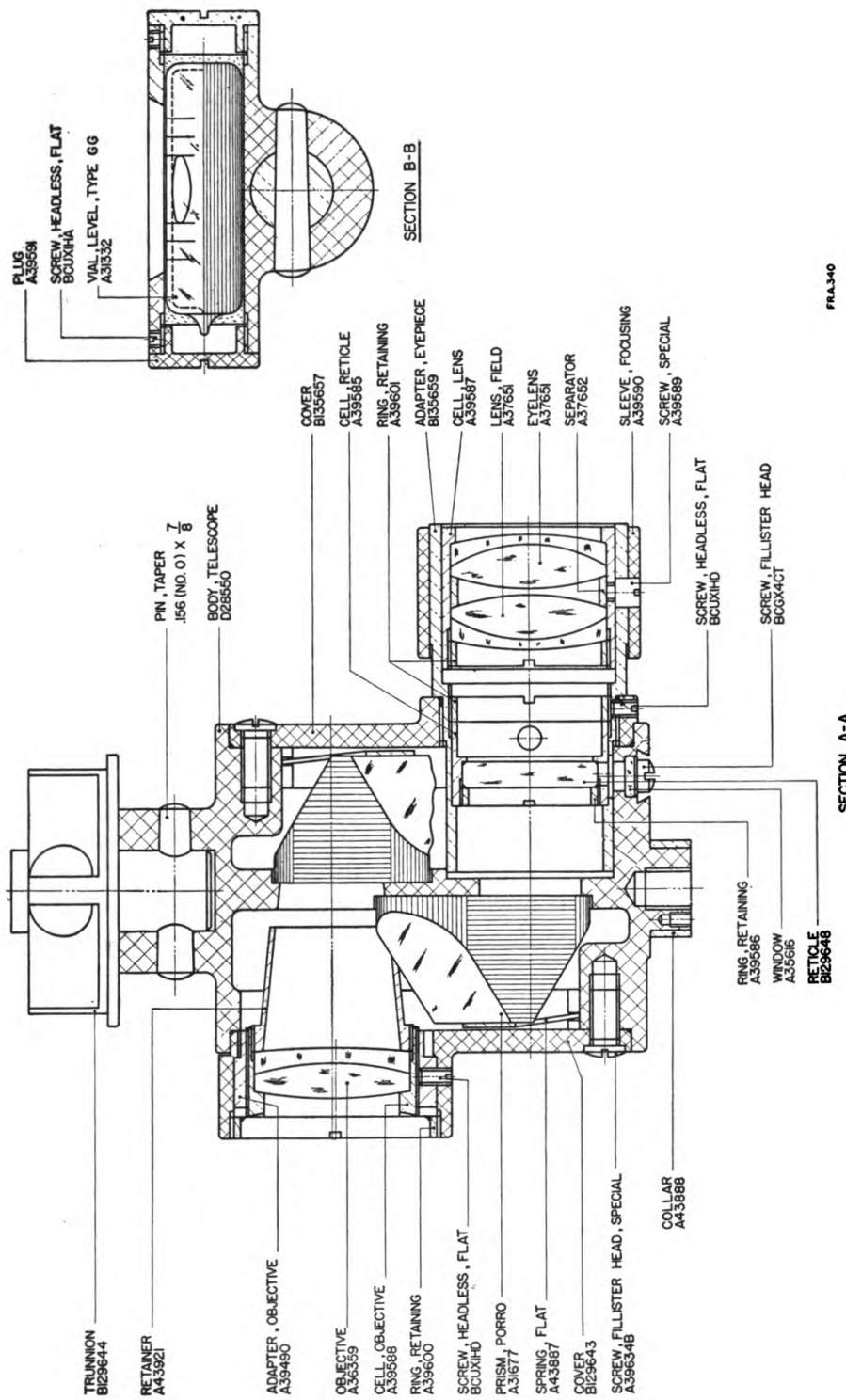



FIGURE 5.—Aiming circle, M1—telescope assembly—sectioned views.

(4) The orienting mechanism is used for rotating the aiming circle in azimuth as a unit.

(*a*) The orienting worm, A39608, meshes with the orienting worm gear, C44750, and is actuated by the orienting worm knob, A39610 (sec. A–A, fig. 2).

(*b*) The clamping screw, A39623 (fig. 2), locks the aiming circle onto the tripod vertical spindle and is released to permit free rotation of the aiming circle for rapid approximate setting in the orienting direction.

*b. Tripod, M5.*—The tripod, M5 (fig. 6), is issued for use with this instrument.

(1) The tripod is constructed of nonmagnetic material throughout.

(2) The tripod legs pivot on the tripod head, C56525, through hinges that are adjusted to provide a tight friction fit. The tripod legs are extensible and may be clamped at the desired height by means of the tripod leg clamping screw, A43950.

(3) The support, C56524, passes through the tripod head. It may be extended and clamped at the desired height by means of the tripod head clamping screw, A43950.

(4) The spindle, A31695, seats in the spindle socket assembly of the support, forming a ball and socket joint for leveling the aiming circle. The spindle is clamped in the socket by means of the socket clamping screw, A43950.

*c. Instrument light, M2.*—The instrument light, M2, provides the electrical illumination of the reticles of the telescope. This light includes a battery case connected by flexible cords to a reticle unit and a hand light. The hand light is held in place by a spring clip on the battery case when not in use. The battery case containing one flashlight cell is arranged to be clamped to a tripod leg and has a switch for controlling both lamps. The reticle unit snaps in place in a dovetailed slot over the reticle window, A35616 (fig. 5), on the telescope.

*d. Carrying case, M6A1.*—A lightweight, nearly cylindrical-shaped carrying case for the aiming circle, tripod, and electrical equipment is provided with this instrument. The aiming circle remains assembled to the tripod when placed in the carrying case, M6A1, and is prevented from shifting by means of special blocking and padding. The bottom plate of the carrying case is formed with an angular V-groove to fit the points of the tripod legs. A compartment is provided for the instrument light, M2. The flashlight cell is removed from the instrument light and placed into a spring clip provided in the carrying case.

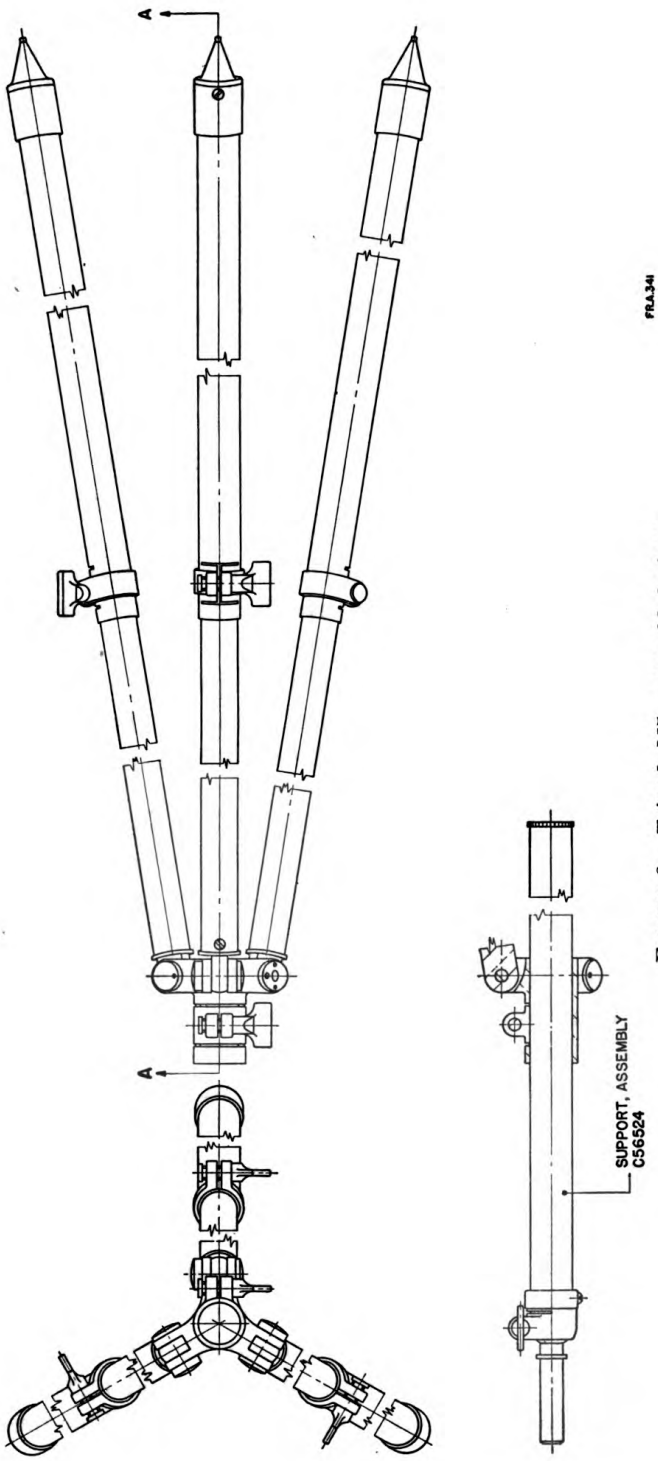



FIGURE 6.—Tripod, M5—assembled views.

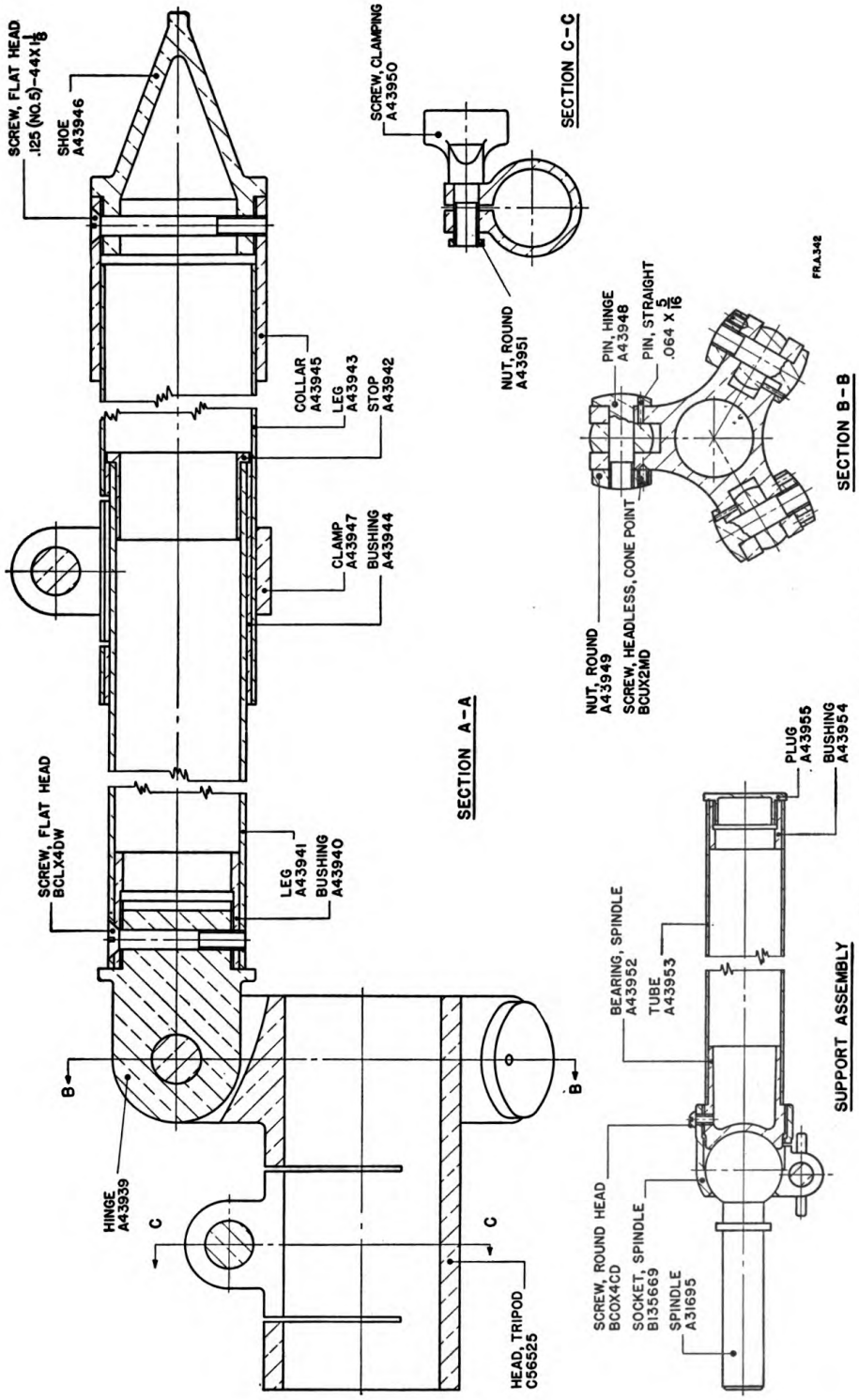



FIGURE 7.—Tripod, M5—sectioned views.

**5. Operation.**—*a. To set up instrument.*—Extend the tripod legs and clamp them at the desired height. Embed the legs firmly in the ground. (When setting up the instrument on a hillside, two of the legs should be embedded on the downhill side.) Place the aiming circle on the tripod spindle, A31695. Level by means of the ball and socket joint of the tripod, and tighten the tripod socket clamping screw, A43950, when the bubble is centered in the circular level vial, A39668.

*b. To orient.*—When the aiming circle is properly oriented, the angle indicated by the azimuth scale and micrometer corresponds to the azimuth angle of the line of sight. There are two methods by which the instrument may be oriented, the method to be used depending on the existing conditions.

(1) *By known azimuths.*—(*a*) Set the azimuth scale and micrometer to indicate the known azimuth of a selected datum point.

(*b*) Turn the aiming circle by means of the orienting mechanism, using either the orienting worm knob, A39610, or the more rapid motion available with the clamping screw, A39623, loosened, until the datum point appears on the verticle cross line of the reticle. Clamp the aiming circle by tightening the clamping screw, A39623, and secure final accurate adjustment of the vertical line on the datum point by means of the orienting worm knob, A39610 (fig. 2).

(2) *By magnetic bearings on magnetic north.*—(*a*) Set the azimuth scale and micrometer to indicate 0 and engage the magnetic needle releasing plunger, A39632A, to permit the magnetic needle to swing free.

(*b*) Turn the aiming circle by means of the orienting mechanism, so that the magnetic needle index, A39627, coincides approximately with the north-seeking (knife edge) end of the magnetic needle.

(*c*) Clamp the aiming circle by means of the clamping screw, A39623, sight through the magnetic needle magnifier, B135660, and by means of the orienting worm knob, A39610, bring the south-seeking end of the magnetic needle to the center of the magnetic needle reticle, A39633. The readings of the azimuth scale and micrometer when so oriented will be magnetic azimuths.

(3) *By magnetic bearings on grid north.*—(*a*) Set off the magnetic declination for the locality on the azimuth scale and micrometer.

(*b*) Turn the instrument by means of the orienting mechanism as above to bring the south-seeking end of the magnetic needle to the center of the magnetic needle reticle, A39633. The readings of the azimuth scale and micrometer when so oriented will be grid azimuths.

*c. To determine angle of site.*—(1) Rotate the the elevating screw knob, A39593, to center the bubble in the telescope level vial, A31332.

(2) Read the angle of site of the object as indicated by the graduations on the vertical line of the eyepiece reticle, B129648.

**6. Inspection.**—Inspection is for the purpose of ascertaining the condition of the aiming circle, whether repairs or adjustments are necessary to insure proper functioning and serviceability. The following list will serve as a guide:

| *Parts to be inspected* | *Points to be observed* |
|---|---|
| *a.* External screws, nuts, and knobs. | *a.* Examine the external screws and nuts for any looseness. Turn the various knobs to see if they are firmly attached to the shafts and function properly. |
| *b.* Circular level vial, A39668. | *b.* Center the bubble between the index lines of the vial. Rotate the instrument 360°. An adjustment of the level vial is necessary if the bubble does not remain central during the rotation. |
| *c.* Magnetic needle, B129647. | *c.* The magnetic needle should swing freely when the needle is on its pivot. |
| *d.* Azimuth mechanism. | *d.* Turn the azimuth knob, A39613, so that the instrument is traversed 360° in azimuth. Note any backlash, sticking or binding in the mechanism by turning the knob to one direction then in the other. If backlash is excessive, replacement or adjustment of the parts involved is necessary. |
| *e.* Level vial, GG, A31332. | *e.* Examine the level vial. Note whether or not the level vial is securely set in its holder. |
| *f.* Elevating mechanism. | *f.* Elevate and then depress the telescope. Observe any binding in the mechanism as the knob is rotated in one direction and then in the other. Note that pressure is exerted by the compression spring, A43923, during this procedure. |

**7. Maintenance and repair.**—*a. Adjustments.*—(1) *To test adjustment of telescope level vial, A31332.*—Set up the instrument and read the angle of site of a distant point of known angle of site. If the angle of site read agrees with value of the point sighted upon, then the level vial is in correct adjustment. This instrument has no provision for adjusting the level vial.

(2) *To calibrate aiming circle with reference to known control line.*—(*a*) Set up the aiming circle at a position that is not subject to local magnetic attraction and from which one or more points of known azimuth can be seen.

(*b*) Orient the instrument by magnetic bearings (par. 5*b*(2)) and measure the corresponding azimuth to each of the known points. Compute the difference between the known azimuths and the measured azimuth. The average of these differences will be the declinator calibration error for the particular instrument, and should be zero when the magnetic needle reticle, A39633, is in correct adjustment.

(*c*) To adjust the magnetic needle reticle, A39633, to coincide with the end of the magnetic needle when the telescope assembly is directed on magnetic north. Adjust the magnetic needle reticle, A39633 (sec. D–D, fig. 3), by loosening the screws, BCGX4CC, and turning the two headless screws, BCUX1KF, so that as one screw is advanced the other screw is backed off until coincidence between the needle and reticle has been reached. Then tighten the two screws, BCGX4CC. If screw driver used is of magnetic material, check the correctness of the adjustment by removing the screw driver from the vicinity of the magnetic needle before tightening the two screws, BCGX4CC.

(3) *To adjust azimuth micrometer, A39621, and plateau micrometer, A39620.*—(*a*) Set the azimuth index to coincide exactly with a graduation on the azimuth scale.

(*b*) Loosen the three fillister head screws, BCGX4DD, holding the micrometer clamping disk, A39622 (fig. 3). Turn the micrometers so that the 0 and 100 graduations correspond exactly with their respective indexes and tighten the clamping disk screws.

*b. Disassembly.*—The assembled and sectioned views show the location of the various parts and the means by which they are held in place. These views should be carefully studied before attempting any disassembling operation.

(1) *To disassemble azimuth worm, B129650.*—(*a*) Remove the micrometer clamping disk, A39622 (fig. 3), by removing the three fillister head screws, BCGX4DD. Remove the azimuth micrometer, A39621, and azimuth plateau micrometer, A39620.

(*b*) Remove the azimuth micrometer adapter, A39619, by driving

out the taper pin which secures the adapter to the worm shaft. Remove the worm shoe, B129649.

(*c*) Unscrew plug, A39625, after loosening the headless flat screw. Remove compression spring, A39345. Plunger, A39624, may be removed after worm is extracted.

(*d*) Unscrew ball cap, A32115, secured by flat headless screw, BCUX1KB. Loosen similar screw which secures ball socket, A32120.

(*e*) Pull out the azimuth worm, B129650, with the ball socket (sec. E–E, fig. 3).

(2) *To disassemble magnetic needle, B129647.*—Remove the end piece, A39629 (sec. C–C–C–C, fig. 2), by removing the two fillister head screws, BCGX4CC, and slide out the plate glass window, B129646. The magnetic needle may now be lifted from its pivot and access for disassembling the magnetic needle plunger yoke, A39595, and associated parts and the circular level vial, A39668, may now be had if necessary.

(3) *To disassemble elevating mechanism, loosen headless flat screw, BCUX3MC, and remove elevating screw plug, A39597, with associated spring.*—Loosen the headless cone point screw from the retaining ring, A39917, and back out the elevating screw, A39592 (fig. 2).

(4) *To disassemble orienting worm, A39608.*—(*a*) Remove the orienting worm housing plate, A39604 (fig. 2), by removing the four flat head screws, BCLX4CC (fig. 1). Remove the orienting worm plunger, A39606, and associated spring, A 39605.

(*b*) Remove both orienting knobs, A39610, by removing the taper pin from each.

(*c*) Unscrew the ball cap, A39607, after loosening the headless flat screw, BCUX1KC. Loosen the similar screw which secures the ball socket, A39603, in position.

(*d*) Remove the orienting worm, A39608, and ball socket, A39603, from the worm housing.

*c. Assembly.*—The procedure for reassembling is the same as for disassembling except in the reverse order. Adjust the ball caps of the orienting worm and azimuth worm shafts to no end shake with a minimum of friction. Lubricate the gears of the azimuth and orienting mechanisms and threads of the elevating screw with grease, special, low temperature.

**8. Tools for maintenance and repair.**—An optical repair kit containing the necessary tools, fixtures, cements, oils, etc., for use with these instruments is furnished to ordnance maintenance companies. A complete list of the items comprising the kit is contained in a blueprint which is fastened in the cover of the chest. Every item

in the kit is designated by a number equivalent to the compartment number. Most of the items such as screw drivers, etc., require no description as their uses are self-explanatory. The collimating telescope, No. 90, which is furnished with the kit is an ordinary nonerecting type. It is adjusted for parallax by the usual means of focusing the eyepiece on the cross wires and then removing parallax by focusing the objective, temporarily loosening the drawtube clamping screw in the side of the telescope for the purpose. The collimating telescope has a magnifying power of 9.78X and a field of view of 4°20′.

## SECTION III

## AIMING CIRCLE, M1918 (FRENCH)



**9. Description.**—The aiming circle, M1918 (French) (fig. 8), is an instrument for use in measuring angles in azimuth and site and for general topographic work. This instrument complete consists of the aiming circle, tripod, type Y, and carrying case, M1 (for aiming circle and tripod).

*a. Aiming circle, M1918 (French).*—The major components of the aiming circle are the telescope assembly and elevating screw mechanism, declinator, azimuth mechanism, and orienting mechanism.

(1) The telescope assembly is used for direct observation of angles in elevation and azimuth within the field of view, and for accurate training on an object as required in the determination of larger angles.

(*a*) The telescope assembly is of the prismatic type. It can be focused to suit the observer's eye by rotating the focusing ring, A31669 (fig. 9), of the eyepiece.

(*b*) The reticle, B10329 (fig. 9), is inscribed with a vertical mil scale and a horizontal mil scale. Each mil scale is graduated at 5-mil intervals 100 mils each side of the point of intersection.

(*c*) The optical characteristics of the telescope assembly are as follows:

| | |
|---|---|
| Power | 4X |
| Field of view | 12° |
| Diameter of exit pupil | .15 inch |
| Aperture of objective | .56 inch |
| Effective focal length of objective | 2.69 inches |
| Effective focal length of eyepiece | .676 inch |

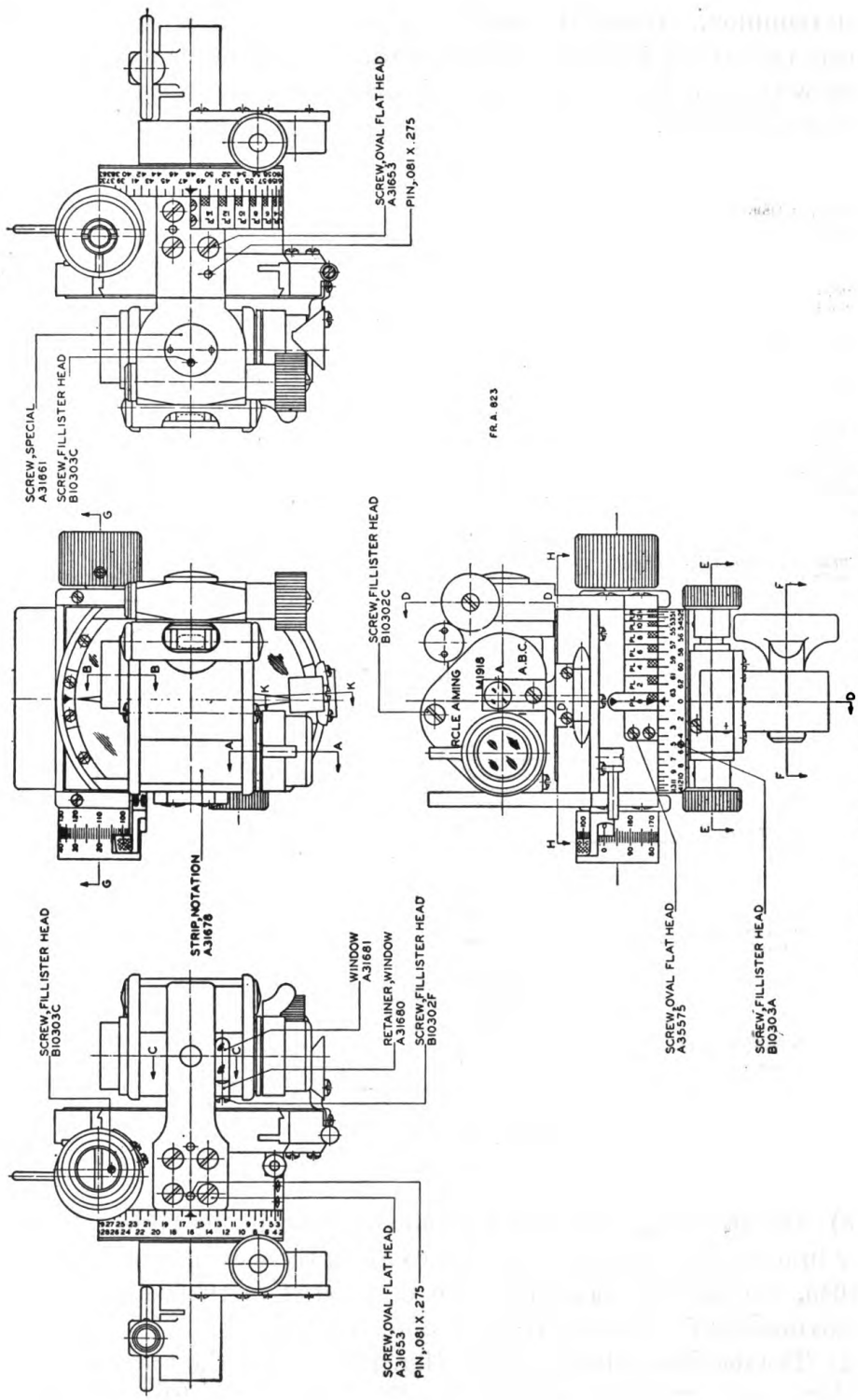



FIGURE 8.—Aiming circle, M1918—assembled views.

(*d*) The telescope level vial, A31332 (fig. 11), is attached to the right trunnion. When the bubble in the level vial is centered, the optical axis of the telescope is horizontal, and the angle of site of an object within the field of view is indicated directly on the vertical mil scale of the reticle.

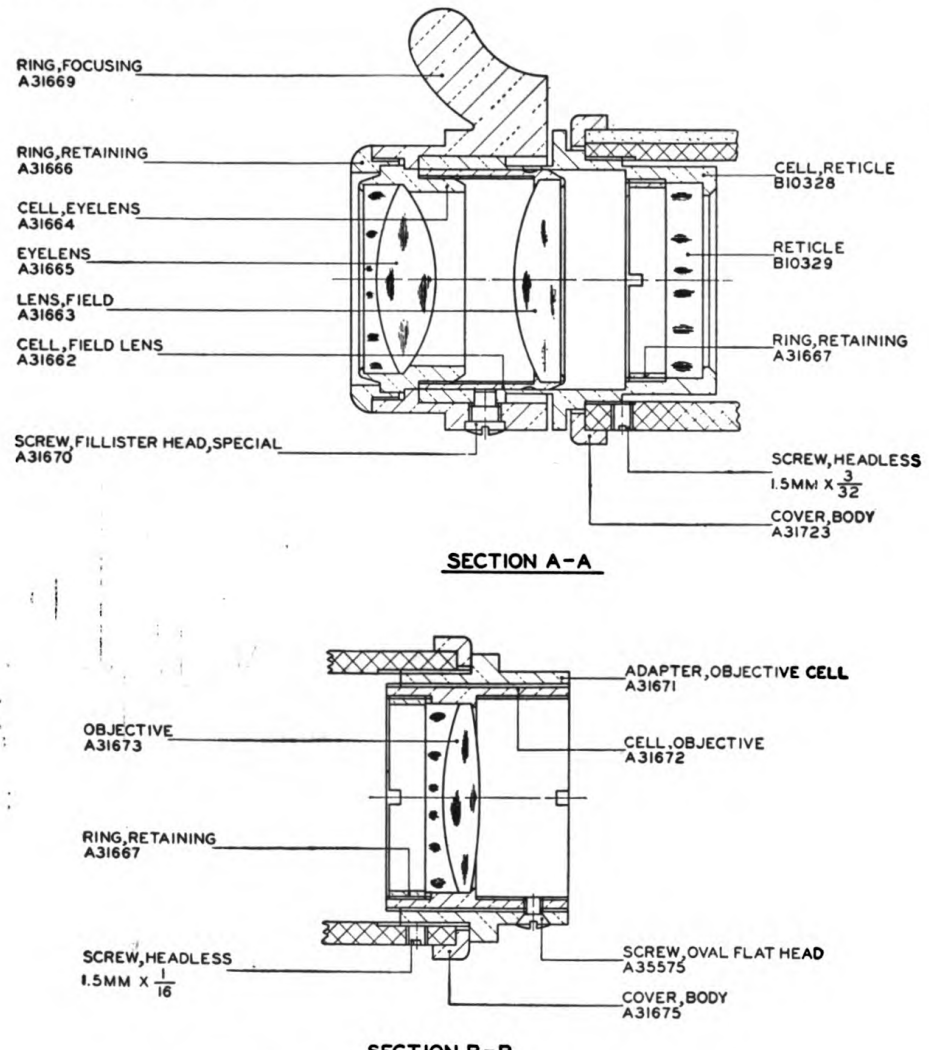


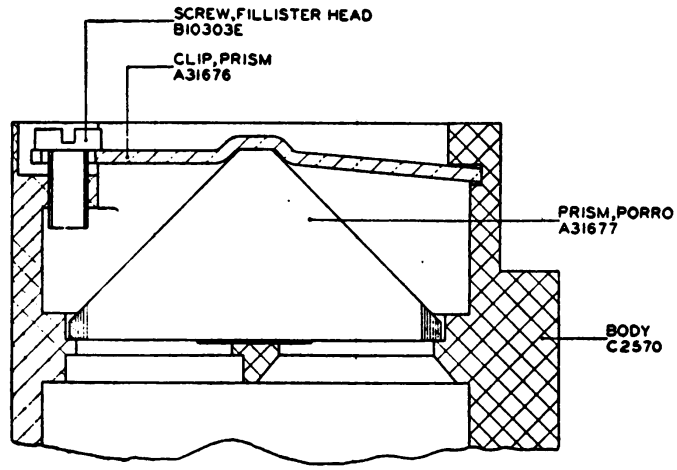

FIGURE 9.—Aiming circle, M1918—sectioned views.

(*e*) The elevating screw mechanism is housed in the right telescope body bracket, B10326 (fig. 11). By rotating the elevating screw knob, A31655, the telescope assembly can be rotated in the vertical plane approximately 7° above or below the horizontal.

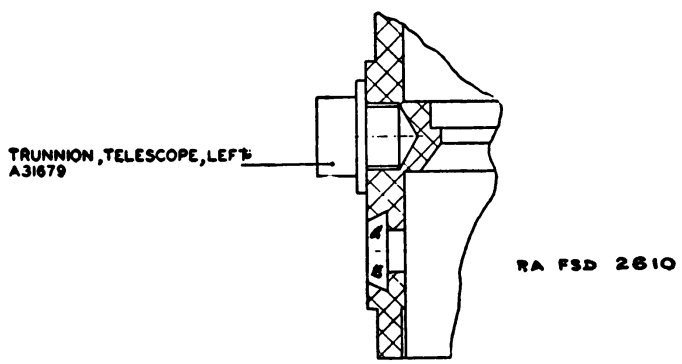
(2) The declinator body, C2569 (fig. 11), carries the telescope body brackets and contains a magnetic needle, A31636 (fig. 10). The mag-

netic needle is raised or lowered on its pivot by means of the declinator locking lever. A circular level vial, A39668, is provided for leveling the declinator.

(3) The azimuth mechanism effects motion of the telescope assembly and declinator in azimuth and indicates the azimuth direction in mils by means of a scale and micrometer.




SECTION THRU PORRO PRISM



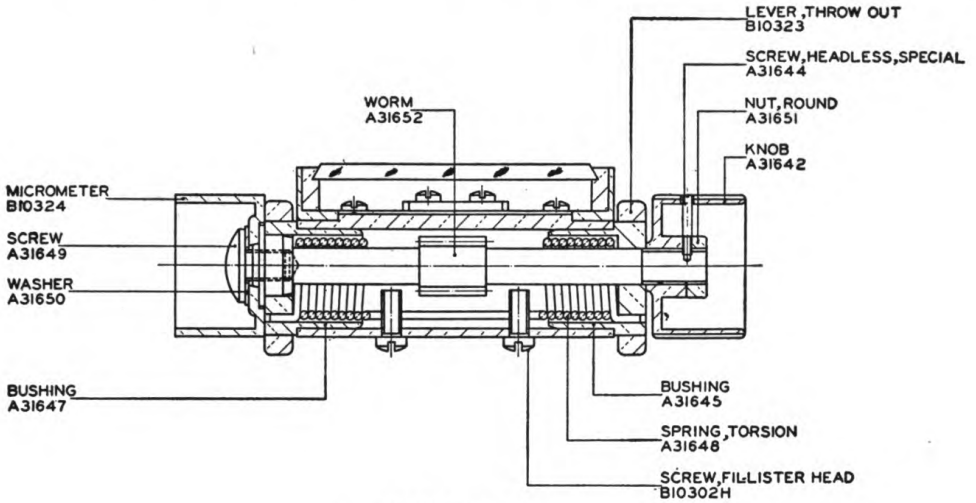

SECTION C-C

FIGURE 9.—Aiming circle, M1918—sectioned views—Continued.

(*a*) The azimuth scale, B10321 (fig. 11), is fastened to the outer rim of the azimuth worm wheel, C2571. The circumference of the azimuth scale is graduated into 64 equal spaces, each representing 100 mils, and numbered from 0 to 64 increasing in a clockwise direction when viewed from above. Arrow index lines are engraved at the 0, 16, 32, and 48

graduations. These index lines are used in conjunction with the azimuth plateau scale for computation of firing data for the sight, M1901 (French).

(*b*) The azimuth index and azimuth plateau scale are engraved on the azimuth index plate, A31631, which is attached to the declinator body, C2569, directly above the azimuth scale. The azimuth plateau



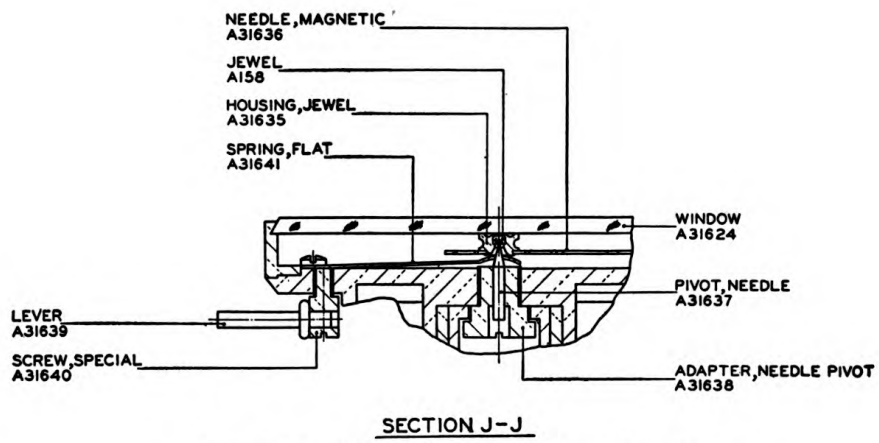
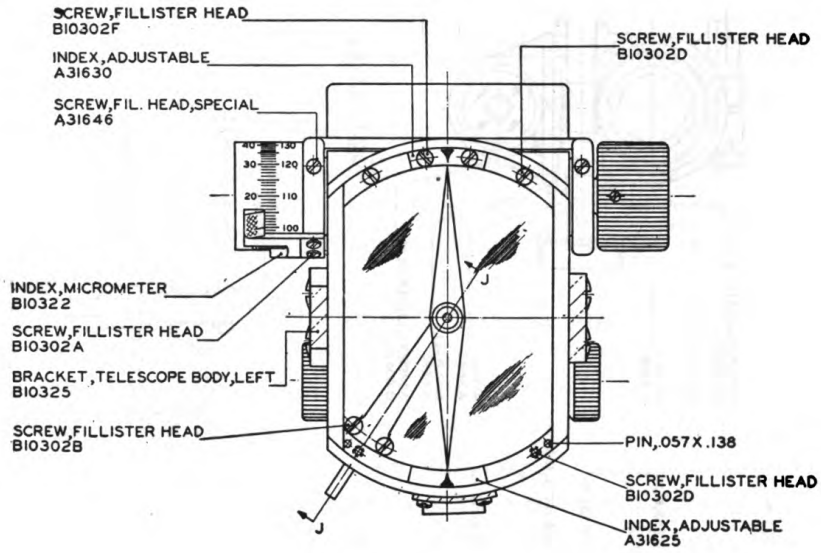




FIGURE 10.—Aiming circle, M1918—sectioned views.

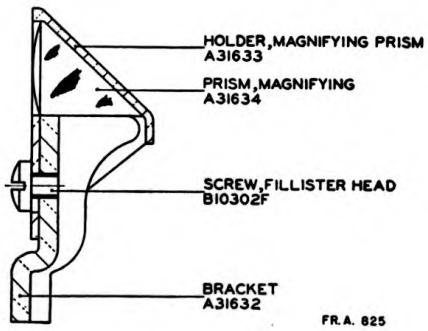
scale consists of a quadrant graduated into eight equal divisions, each representing an angle of 200 mils and numbered from 0 to 16. Each division is halved and the alternate 100-mil spaces thus formed are cross-hatched for reference to the azimuth micrometer, B10324.

(*c*) The azimuth micrometer, B10324 (fig. 10), is attached to the azimuth worm, A31652, and actuated by the azimuth worm knob,

A31642, so as to rotate through a complete revolution as the azimuth index is advanced through an angle of 100 mils. The micrometer is graduated into 100 equal spaces, each representing 1 mil, numbered from 0 to 100 on the outer edge and from 100 to 200 on the inner edge.




SECTION H-H




SECTION K-K

FIGURE 10.—Aiming circle, M1918—sectioned views—Continued.

1. The 0 to 200 graduations are used in conjunction with the graduations on the azimuth scale.
2. The 100 to 200 graduations are used in conjunction with the graduations on the azimuth plateau scale. When using the azimuth plateau scale, if an index at 0, 16, 32, or 48 points into a clear space the 0 to 100 graduations are read; if an index points into a cross-hatched space the 100 to 200 graduations are read.

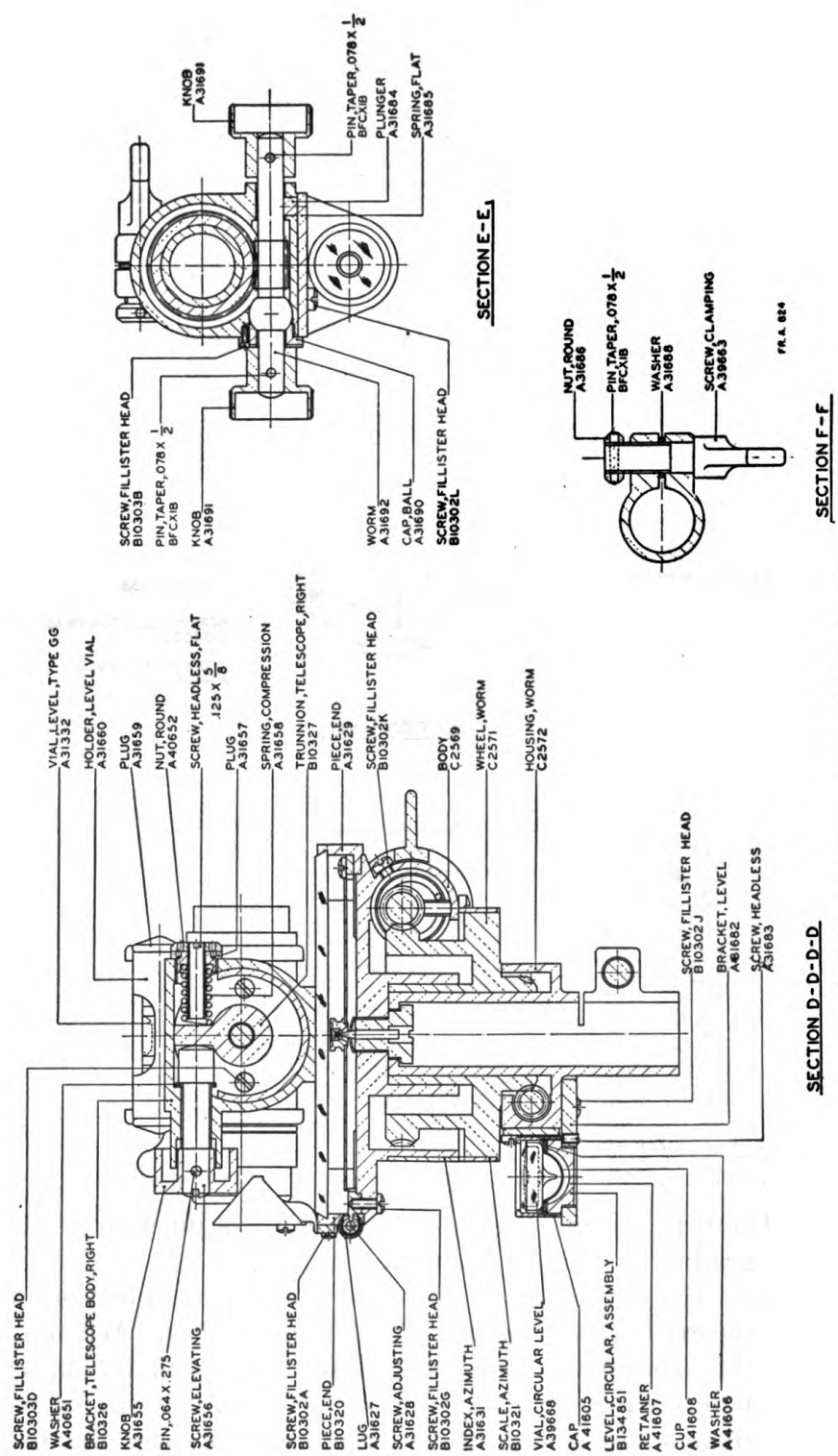



FIGURE 11.—Aiming circle, M1918—sectioned views.

(*d*) The azimuth worm, A31652 (fig. 10), may be disengaged from the teeth of the azimuth worm gear to permit rapid approximate setting in azimuth. The disengagement is accomplished by depressing the azimuth worm throw-out lever, B10323.

(4) The orienting mechanism is used for rotating the aiming circle as a unit.

(*a*) The orienting worm, A31692, meshes with the orienting worm wheel, C2571 (sec. D–D–D–D, fig. 11). This mechanism is actuated by rotating the knobs secured to the orienting worm shaft.

(*b*) A clamping screw, A39663, is provided for locking the aiming circle onto the tripod vertical spindle, and may be released to permit free rotation for a rapid approximate setting in the orienting direction.

*b. Tripod, type Y.*—The tripod, type Y (fig. 12), is issued with the instrument. For replacements in the future, however, the tripod, M5, will be issued (par. 4*b*).

(1) The tripod is constructed of nonmagnetic material throughout.

(2) The tripod legs pivot on the tripod head, B10300, through hinges, A31529, that are adjusted to provide a tight friction fit. The legs are extensible and may be clamped at the desired height by means of the tripod leg clamping screws.

(3) The support, C44796, passes through the tripod head. It is extensible and may be clamped at the desired height by means of the tripod head clamping screw. The spindle, A31695 (fig. 12), seats in the spindle socket assembly of the support, forming a ball and socket joint for leveling the aiming circle. The spindle is clamped in the socket by means of the socket clamping screw, A38373.

*c. Carrying case, M1 (for aiming circle and tripod).*—A sturdy, lightweight, nearly cylindrical-shaped carrying case is provided. The aiming circle remains assembled to the tripod when placed in the carrying case, and is prevented from shifting by means of special blocking and padding. The bottom plate of the carrying case is formed with an angular V-groove to fit the points of the tripod legs.

**10. Operation.**—*a. To set up instrument.*—Extend the tripod legs to the desired height, clamp and embed them firmly in the ground. (When setting up the instrument on a hillside, two of the legs should be embedded on the downhill side.) Place the aiming circle on the tripod spindle, A31695 (fig. 12). Level by means of the ball and socket joint of the tripod and tighten the clamping screw when the bubble is centered in the circular level vial.

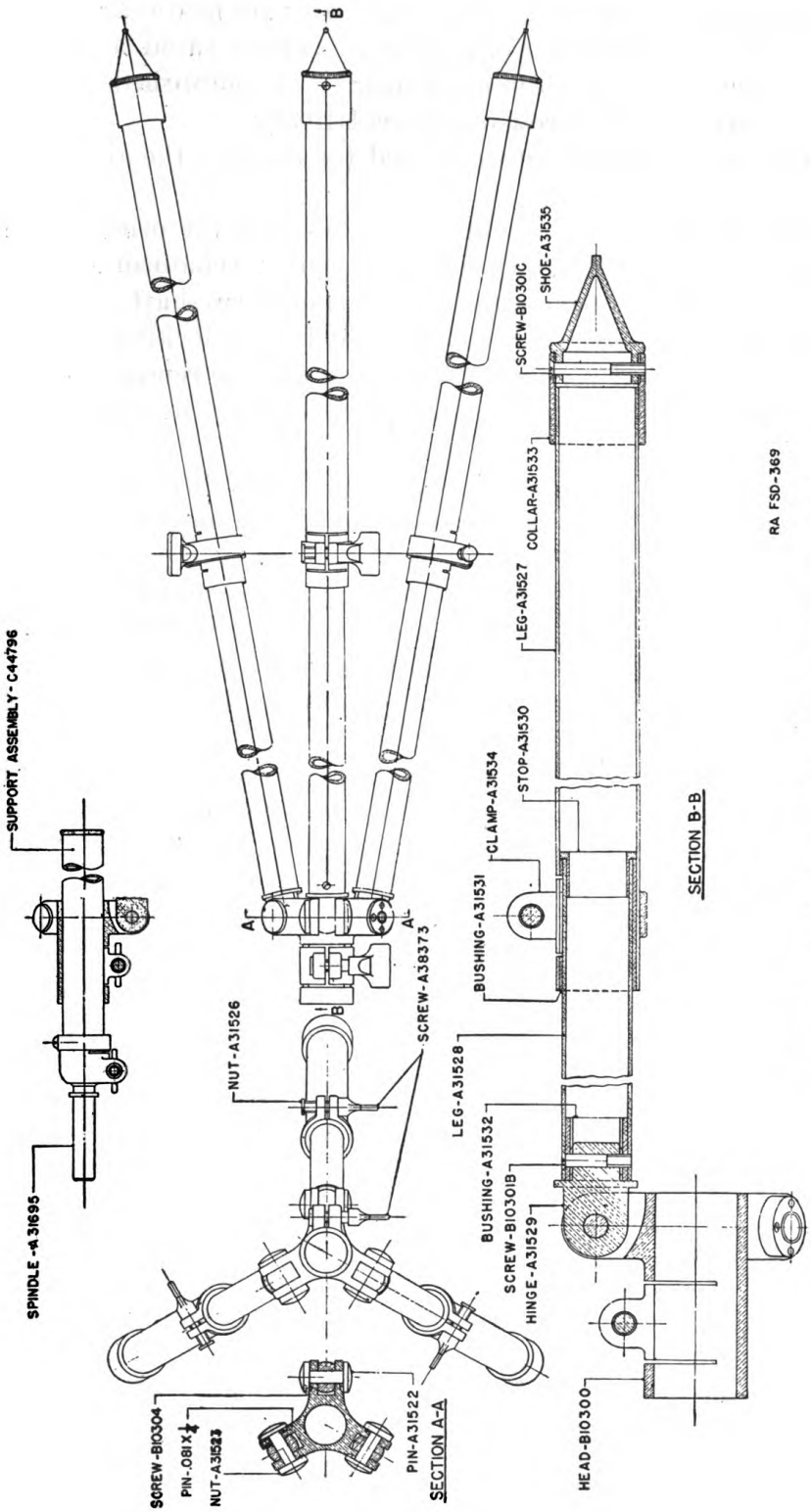



FIGURE 12.—Tripod, type Y—assembled and sectioned views.

*b. To orient.*—When the aiming circle is properly oriented, the angle indicated by the azimuth scale and micrometer corresponds to the azimuth angle of the line of site. There are two methods by which the instrument may be so oriented, the method to be used depending on the existing conditions.

(1) *By known azimuths.*—(*a*) Set the azimuth scale and micrometer to indicate the known azimuth of a selected datum point.

(*b*) Turn the aiming circle by means of the orienting mechanism, using either the orienting worm knob or the more rapid motion available when the clamping screw is loosened, until the datum point appears on the vertical cross line of the reticle. Clamp the aiming circle by tightening the clamping screw and secure final accurate adjustment of the vertical line on the datum point by means of the orienting worm knob.

(2) *By magnetic bearings on magnetic north.*—(*a*) Set the azimuth scale and micrometer to indicate "0" and rotate the declinator locking lever so as to permit the magnetic needle to swing free.

(*b*) Turn the aiming circle by means of the orienting mechanism so that the declinator indexes coincide approximately with the ends of the magnetic needle.

(*c*) Clamp the aiming circle by tightening the clamping screw, A39663 (fig. 12), and by means of the orienting worm knob bring the south-seeking end of the magnetic needle to exact alinement with the declinator rear index, A31625, as viewed through the magnifying prism, A31634. The readings of the azimuth scale and micrometer when so oriented will be magnetic azimuths.

*c. To determine angle of site.*—Rotate the elevating screw knob to center the bubble in the telescope level vial. The angle of site of an object is then indicated by the graduations on the vertical line of the eyepiece reticle.

**11. Inspection.**—Inspection is for the purpose of determining the condition of the instrument, and whether adjustments or repairs are necessary to insure serviceability and proper functioning. The following list will serve as a guide:

| *Parts to be inspected* | *Points to be observed* |
|---|---|
| *a.* External screws, pins, and plugs. | *a.* Examine the instrument for loose or missing screws, pins, and plugs. |
| *b.* Azimuth mechanism. | *b.* Turn the azimuth knob, A31642, so that the instrument is traversed 360° in azimuth and observe any sticking or binding in |

| *Parts to be inspected* | *Points to be observed* |
|---|---|
| | the mechanism. Note any backlash. If it is excessive, replacement or adjustment of parts involved is necessary. |
| *c.* Rear declinator index, A31625. | *c.* Direct the telescope assembly on magnetic north. Correct adjustment is indicated when the rear declinator index, A31625, coincides with the end of the magnetic needle. |
| *d.* Elevating knob, clamping screws, locking lever, and throwout lever. | *d.* Operate each of these parts to determine whether or not each functions properly. |
| *e.* Circular level vial, A39668. | *e.* Center the bubble in the level vial. Rotate the instrument 360°. If the bubble does not remain central, adjustment of the level vial screw, A31683, is necessary. |
| *f.* Magnetic needle, A31636. | *f.* The magnetic needle should swing freely on its pivot. |
| *g.* Level vial, type GG, A31332. | *g.* Examine the level vial. Note whether or not the level vial is firmly set in its holder. |

**12. Maintenance and repair.**—*a. Adjustments.*—(1) *To test adjustment of telescope level vial, A31332.*—Set up the instrument and read the angle of site of a distant point of known angle of site. Correct adjustment is indicated when the angle of site read agrees with the value of the known point. No adjustment of level vial is provided on the instrument.

(2) *To calibrate declinator with reference to known control line.*—(*a*) Set up the instrument in a locality not subject to local magnetic attraction.

(*b*) Orient the instrument by magnetic bearings (par. 10*b*(2)) and measure the corresponding azimuth to each of the known points.

(*c*) Compute the difference between the known azimuths and measured azimuths. The average of these differences will be the declinator calibration error. (It should be zero when the rear declinator index, A31625 (fig. 10), is in correct adjustment.)

(3) *To adjust rear declinator index.*—The rear declinator index, A31625 (fig. 10), is adjustable and may be set to coincide with the end of the magnetic needle when the telescope assembly is directed

on magnetic north. Adjust the index by loosening the index clamping screw, B10302G (fig. 11), and turn the index adjusting screw, A31628, until coincidence has been reached. If screw driver used is of magnetic material, check the correctness of the adjustment by removing the screw driver from the vicinity of the magnetic needle before tightening the two screws, BCGX4CC. Tighten the index clamping screw after the adjustment has been completed.

*b. Disassembly.*—(1) *To disassemble azimuth worm, A31652* (fig. 10).—(*a*) Remove the azimuth worm knob, A31642, by loosening the headless screw, A31644, and removing the round nut, A31651.

(*b*) Remove the two fillister head screws, B10302H, and unmesh the azimuth worm, A31652, by means of the throw-out lever, B10323.

(*c*) Remove the three fillister head screws, A31646, holding the eccentric bushing, A31647, in position. Withdraw the micrometer, B10324, from the housing, thus removing the worm together with bushing and torsion spring, A31648, from the body of the aiming circle.

(*d*) Disassembly can be carried out further if necessary. When reassembling, care should be exercised to have the torsion spring properly fitted into the bushings before replacing any screws.

(2) *To disassemble declinator.*—Remove the end piece, B10320 (fig. 11), by removing the two fillister head screws, B10302D, from the body of the aiming circle. Carefully slide out the plate glass window, A31624. Lift the magnetic needle, A31636, from its pivot. Carry out the disassembly of the associated parts of the magnetic needle further if necessary.

(3) *To disassemble orienting worm, A31692.*—Remove the right orienting worm knob, A31691 (sec. E–E, fig. 11). Loosen the plunger spring screw, B10302L. Remove the ball cap fillister head screw, B10303B. Rotate the other orienting knob in such direction to unthread the worm from the gear teeth. Extract the worm together with the ball cap from the worm housing.

*c. Assembly.*—The reassembling procedure is the same as when disassembling except in the reverse order. Adjust the ball cap of the orienting worm shaft to no end shake with a minimum of friction. Lubricate the gears of the orienting and azimuth mechanisms and the threads of the elevating screw, A31656, with grease, special, low temperature.

**13. Tools for maintenance and repair.**—For the tools incident to the maintenance and repair of the equipment see paragraph 8.

## SECTION IV

## AIMING CIRCLE, M1916 AND M1916MI



**14. Description.**—The aiming circle, M1916 or M1916MI (figs. 13 to 18, incl.), is an instrument for use in measuring angles in azimuth and site and for general topographic work.

*a.* Two types of instruments of the M1916 series exist at the present time: those made by the Spencer Lens Co., being designated as the M1916; and those made by Bausch and Lomb and Frankford Arsenal, being designated as the M1916MI. The two aiming circles are generally the same, differing mainly in the design of the azimuth housing and azimuth worm parts. The proper type designation of the instrument is stamped on the telescope elbow cover.

*b.* The aiming circle, M1916 or M1916MI, complete, consists of the aiming circle, mount for aiming circle, tripod, type G, and the following accessory equipment: stand for aiming circle, carrying case for aiming circle, and carrying case for tripod.

*c.* The major components of the aiming circle, M1916 or M1916MI, are the telescope assembly, elevating mechanism, and angle of site mechanism, declinator, and azimuth mechanism.

(1) The telescope assembly is used for direct observation of angles in elevation and azimuth within the field of view, and for accurate training on an object as required in the determination of larger angles.

(*a*) The telescope assembly is of the prismatic type with the optical system so arranged that the eyepiece is inclined at an angle of 60° above the emergent line of sight.

(*b*) The reticle, B129427 (fig. 14), is inscribed with a vertical mil scale and a horizontal mil scale. Each scale is graduated in 5-mil intervals 85 mils each side of the point of intersection.

(*c*) The telescope assembly has the following optical characteristics:

| | |
|---|---|
| Power | 4.18X |
| Field of view | 10° |
| Effective focal length of objective | 2.25 inches |
| Effective focal length of eyepiece | .537 inch |
| Diameter of exit pupil | .129 inch |

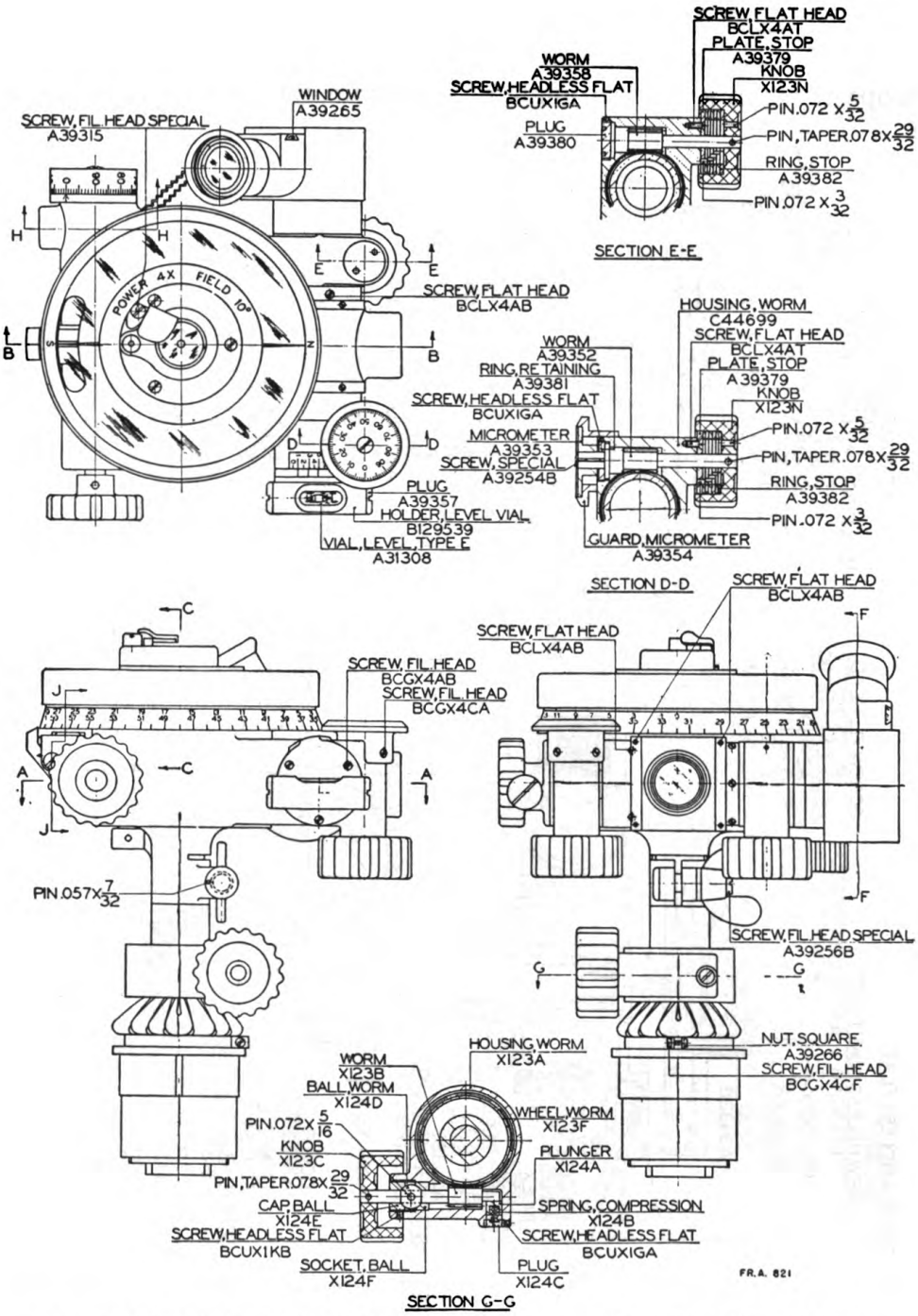



FIGURE 13.—Aiming circle, M1916, and mount—assembled and sectioned views.

(*d*) The objective prism housing, C44508 (fig. 14), is fitted with a protecting shutter to exclude dust and dirt when the instrument is not being used.

(2) The elevating mechanism rotates the line of sight of the telescope through a vertical angle of approximately 18° above or below

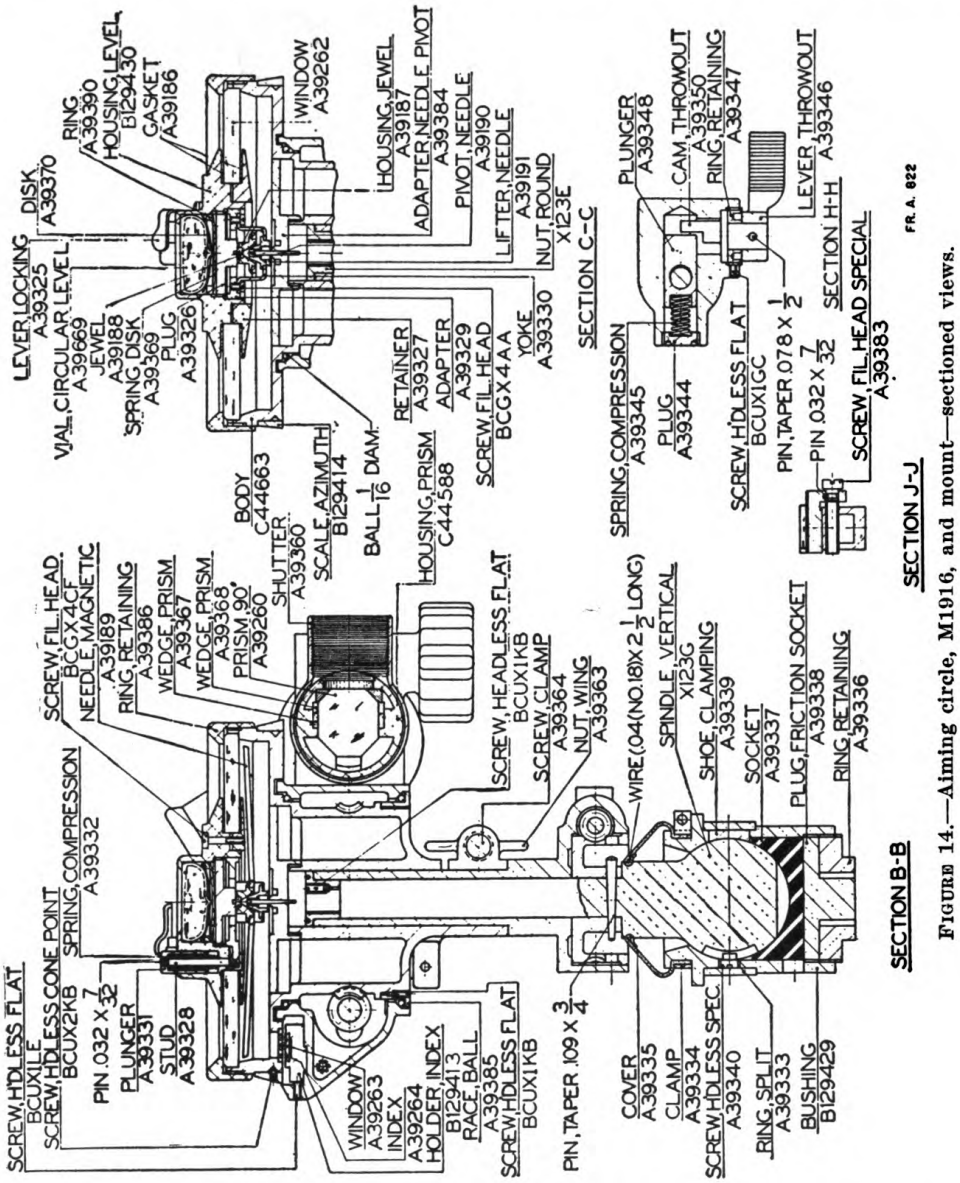



FIGURE 14.—Aiming circle, M1916, and mount—sectioned views.

the horizontal. The angle corresponding to any setting in elevation is determined by means of the angle of site mechanism.

(*a*) The elevating mechanism is actuated by the elevating worm knob, X123N (sec. E–E, fig. 13), and is contained in the projecting

portion of the azimuth worm housing, D25577 (M1916), D25557 (M1916MI) (figs. 14 and 17), which carries the telescope assembly.

(*b*) The angle of site mechanism is attached to the objective end of

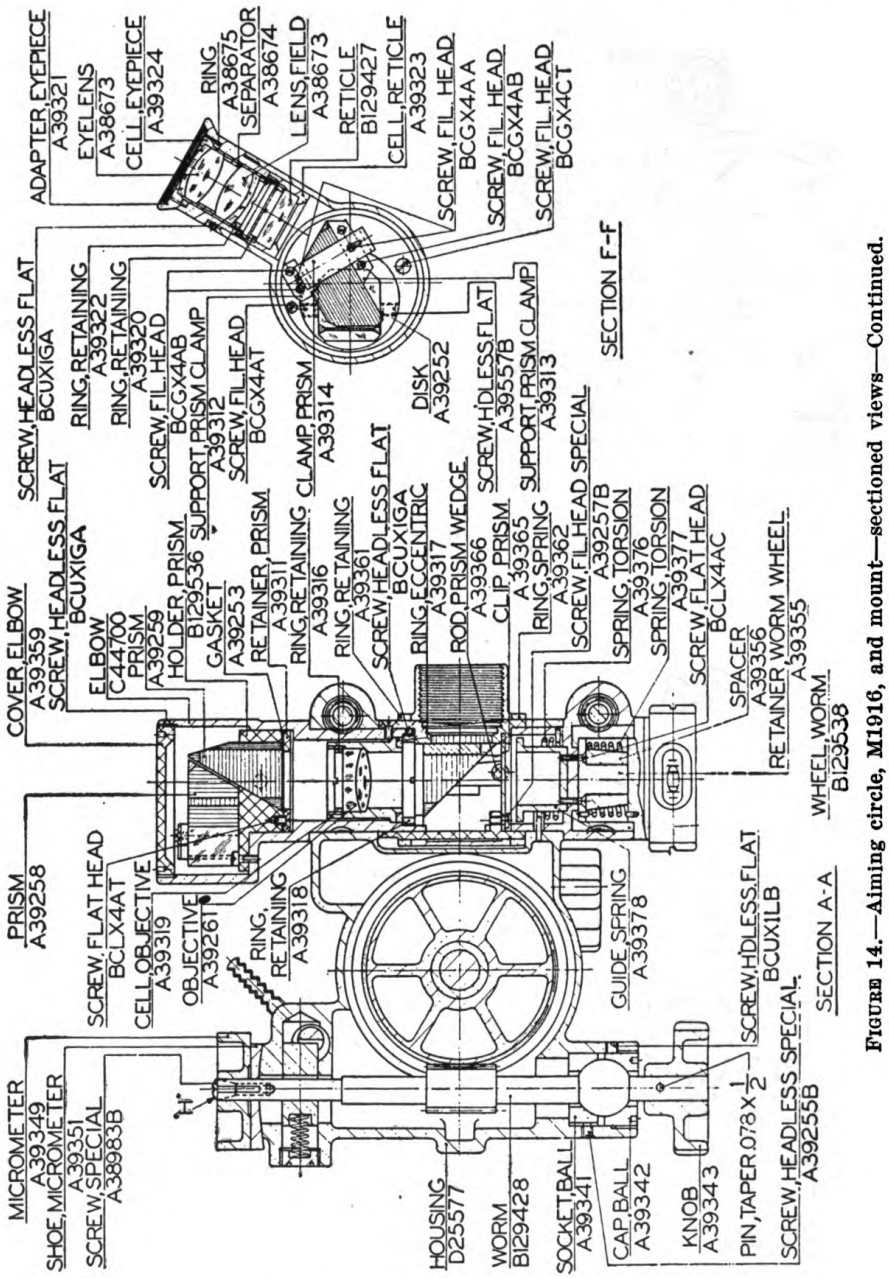



FIGURE 14.—Aiming circle, M1916, and mount—sectioned views—Continued.

the telescope and consists mainly of an angle of site scale and micrometer, A39353 (fig. 13), which indicates the vertical angle between the line of sight and the axis of a level vial, A31308 (fig. 15).

*1.* The angle of site scale is engraved on the angle of site worm housing, C44699. It is graduated into six equal spaces each representing 100 mils and numbered from 0 to 6, the

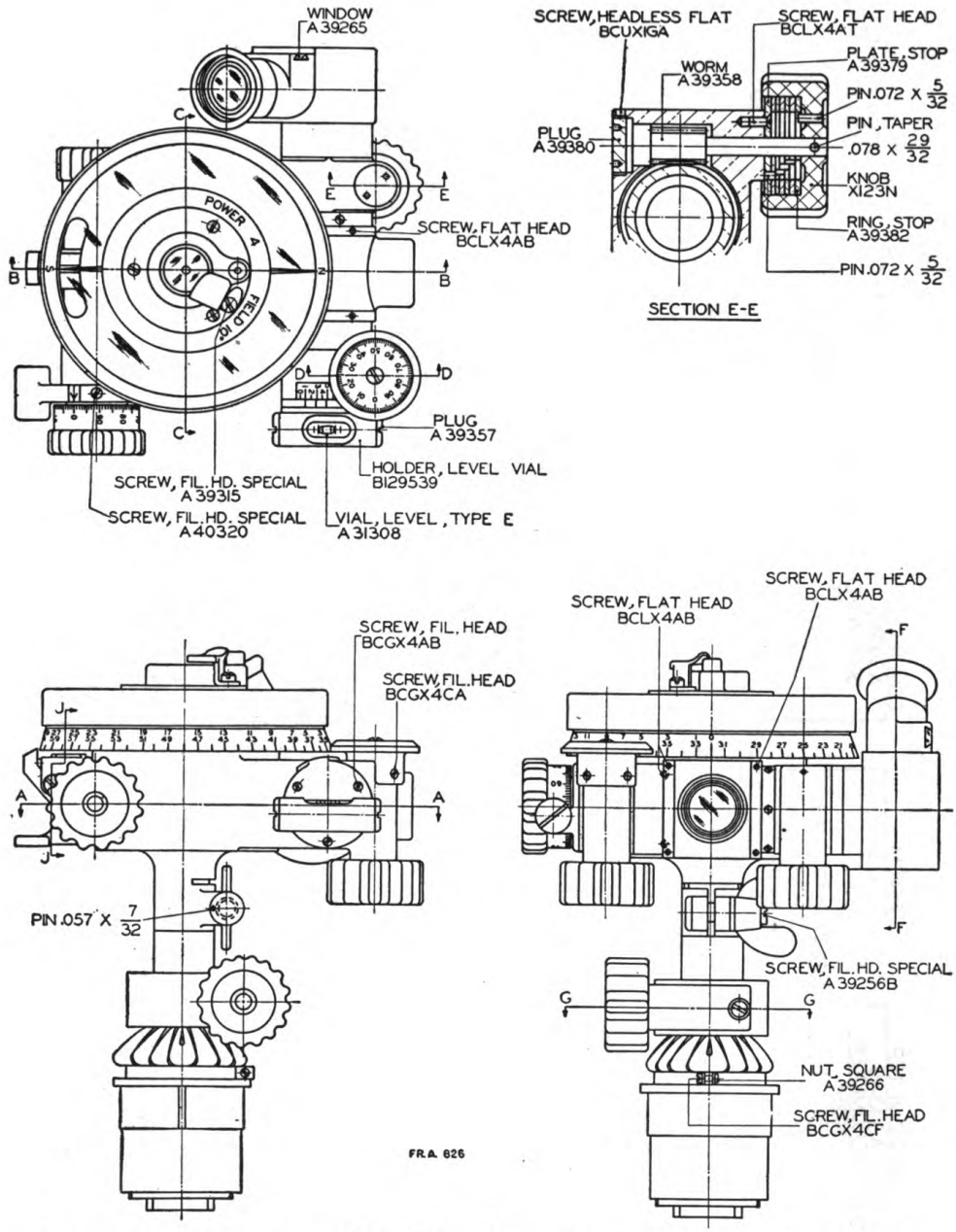



FIGURE 15.—Aiming circle, M1916 MI, and mount—assembled and sectioned views.

3 graduation indicating the horizontal position of the line of sight. The angle of site micrometer, A39353, is gradu-

ated at its circumference into 100 equal spaces, each representing 1 mil and numbered from 0 to 100.

*2.* The level vial, A31308, is rotated in the vertical plane parallel to the line of sight by means of the angle of site worm knob, X123N. This knob also actuates the angle of site micrometer, A39353, and rotates it through an angle corresponding to the motion of the index on the angle of site scale.

(3) The declinator is housed in the top of the aiming circle body, C44663 (fig. 14). It contains a magnetic needle, A39189, which provides initial orienting direction.

(*a*) Arrow index lines which indicate the north and south directions are engraved on the inside portion of the body, C44663, which forms the declinator housing. The rotation of the magnetic needle is constrained so that the north- and south-seeking ends are always in the vicinity of their respective indexes.

(*b*) A declinator mirror index, A39264 (fig. 14), enables accurate alinement of the south-seeking end of the magnetic needle.

(*c*) The magnetic needle, A39189, is raised or lowered on its pivot by means of the magnetic needle release plunger, A39331. This plunger is held down in the operating position by means of the declinator locking lever, A39325.

(*d*) A circular level vial, A39669 (fig. 16), is mounted on the magnetic needle window, A39262, of the declinator. The instrument is level when the bubble is concentric with the etched circle on the top of the vial.

(4) The azimuth mechanism rotates the telescope assembly in azimuth, and indicates the azimuth direction in mils by means of a scale and micrometer.

(*a*) The azimuth scale, B129414, is attached to the body, C44663, of the aiming circle. The graduations of the main azimuth scale are numbered from 0 to 64. A second set of graduations forms an auxiliary scale for angles between 3200 and 6400 mils on the main scale. This auxiliary scale is numbered from 0 to 32, and so located that the 0 graduation coincides with the 32 graduation on the main scale. The auxiliary scale is for use in reciprocal laying of guns equipped with sights graduated 0–3200, 0–3200.

(*b*) The azimuth worm housing and azimuth worm parts for the aiming circle, M1916MI, are designed differently from the M1916. The azimuth worm, B129428 (fig. 14), of the M1916 instrument has a knob, A39343, on one end and a micrometer, A39349, on the other end, and the azimuth worm throw-out lever, A39346, is positioned at

the end of the worm toward the micrometer. The azimuth worm, B129548 (fig. 17), of the M1916MI instrument has only one knob,

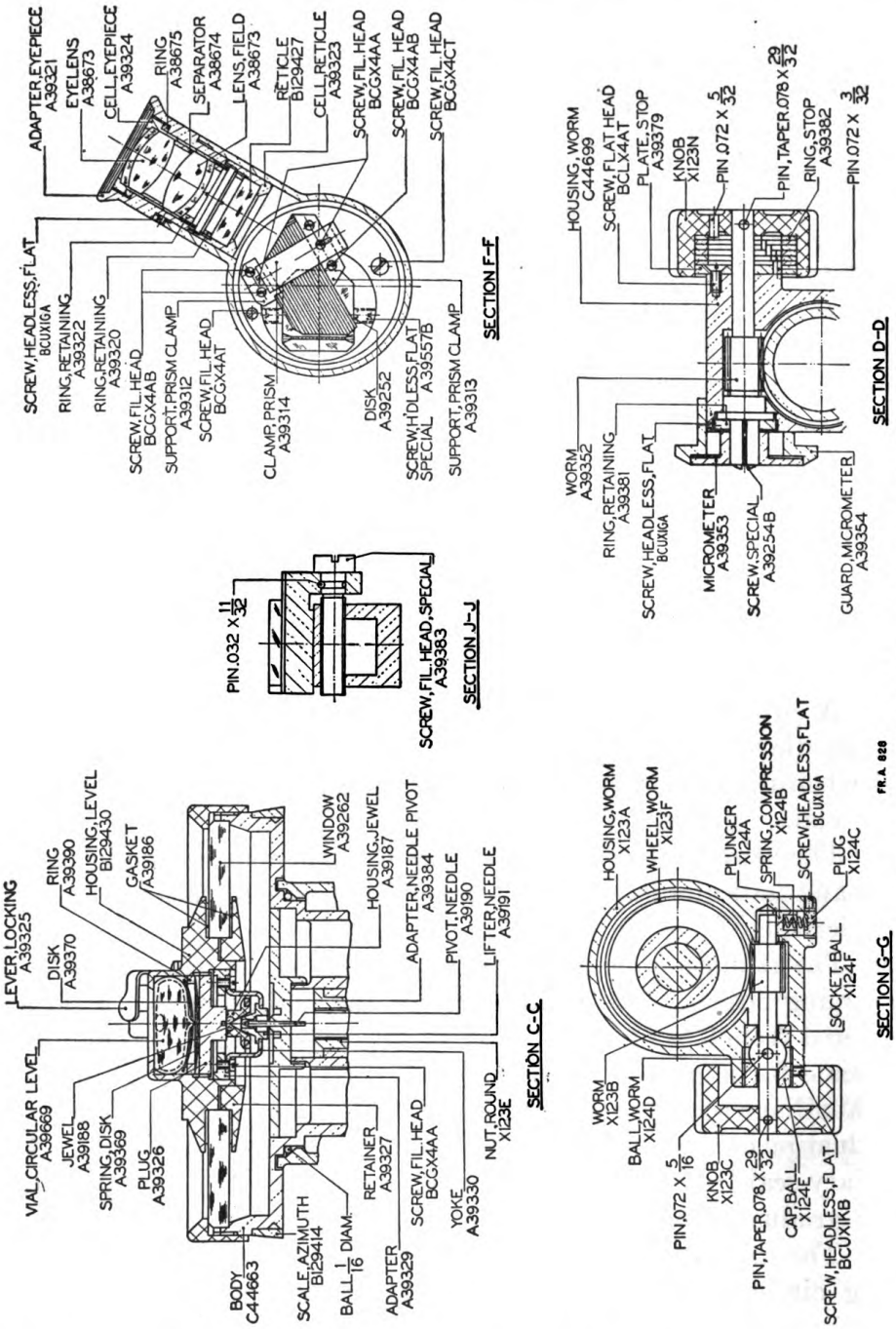



FIGURE 16.—Aiming circle, M1916MI, and mount—sectioned views.

A40314, with micrometer readings engraved thereon, and the azimuth worm throw-out lever, A40315, is located in proximity to this knob.

*1.* The azimuth micrometer is attached to the azimuth worm and actuated by the azimuth worm knob so as to rotate through a complete revolution as the azimuth index is advanced through an angle of 100 mils. The circumference of the azimuth micrometer is graduated into 100 equal spaces numbered from 0 to 100 so that each space represents 1 mil.

*2.* The azimuth worm throw-out lever, when rotated and held, causes disengagement of the azimuth worm from the worm gear and thereby permits rapid approximate setting in azimuth.

*d.* The mount contains the orienting worm mechanism for turning the entire aiming circle in azimuth, and a ball and socket joint which is used for leveling the instrument in conjunction with the circular level vial, A39669 (sec. C–C, fig. 14).

(1) The mount is normally carried in the head bushing of the tripod, type G (fig. 18). A locking screw passing through the tripod head engages a drilled hole in the lower vertical spindle bushing, B129429 (sec. B–B, fig. 17), of the mount preventing loss or withdrawal. A split ring, A39333, on the mount engages three clamping shoes, A39339, which bear on the ball-shaped surface of the vertical spindle, X123G (sec. B–B, fig. 17). The clamping screw lever, X59B (fig. 18), compresses this ring to hold the vertical spindle securely in position when the instrument is leveled.

(2) The orienting worm housing, X123A (sec. G–G, fig. 13), is formed with an integral sleeve extension which fits over the shaft of the vertical spindle, X123G. The aiming circle fits over this portion of the housing and is clamped to it by means of the wing nut, A39363 (sec. B–B, fig. 17). This wing nut is loosened to permit free rotation of the aiming circle for rapid approximate setting in the orienting direction. With the wing nut clamped, rotation is obtained by turning the orienting worm knob, X123C (sec. G–G, fig. 13).

*e.* The tripod, type G (fig. 18), is issued for use with this instrument.

(1) The tripod is constructed of nonmagnetic material throughout. Each of the tripod leg assemblies, C44592 (fig.18), is pivoted on the tripod head, X60A, and may be clamped on the head by tightening the clamping screw lever, X60E. The tripod legs are extensible and may be clamped at a desired length.

(2) The tripod head, X60F, contains the tripod head bushing, X219B, the upper portion of which may be contracted for clamping the ball and socket joint of the mount.

*f.* A nonmagnetic stand is provided to support the aiming circle in an upright position when removed from the tripod and mount. The stand is formed with a fiducial edge, permitting the use of the aiming circle as an alidade when used on a plotting board for topographical purposes.

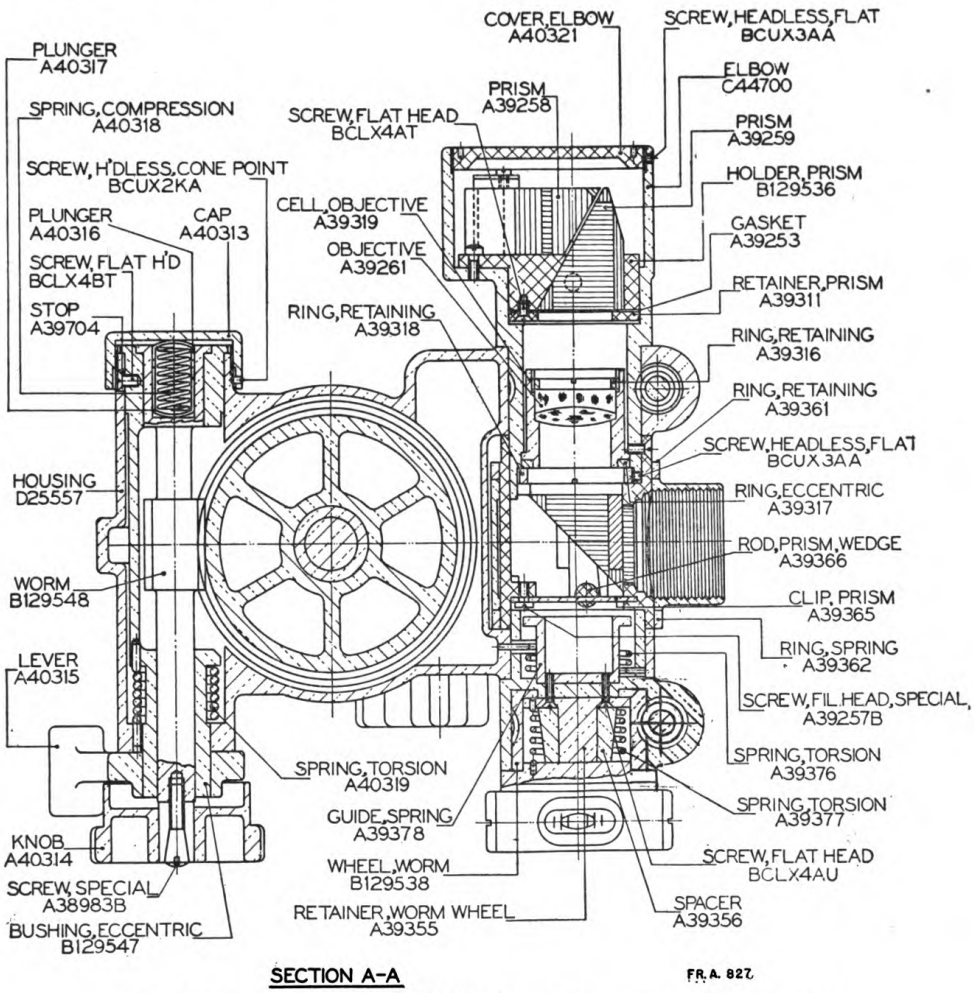



FIGURE 17.—Aiming circle, M1916MI, and mount—sectioned views.

*g.* The carrying case for aiming circle, M1916 or M1916MI, is a leather case provided with internal blocks and supports for holding the aiming circle and stand firmly in position.

*h.* The carrying case for the tripod, type G, consists of a top hood and base hood for covering the ends of the tripod, fastening straps for securing the tripod legs, and shoulder and waist straps for carrying. The mount remains assembled to the tripod when placed in the carrying case.

**15. Operation.**—*a. To set up instrument.*—Extend the tripod legs to the desired height and embed them firmly in the ground. (When setting up the instrument on a hillside, two of the legs should be embedded on the downhill side.) Place the aiming circle on the mount,

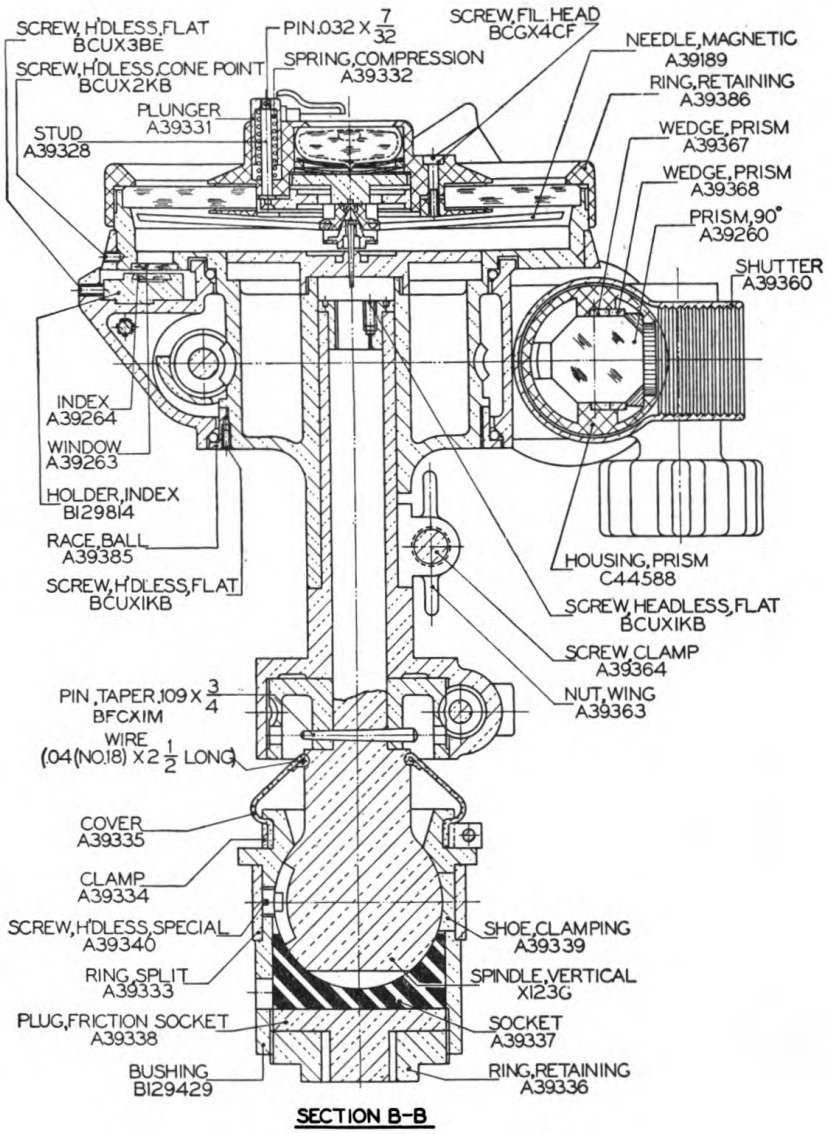



FIGURE 17.—Aiming circle, M1916MI, and mount—sectioned views—Continued.

level by means of the ball and socket joint, and tighten the clamping screw lever, X59B (fig. 18), of the tripod head bushing when the bubble is centered in the circular level vial, A39669.

*b. To orient instrument.*—When the aiming circle is properly oriented, the angle indicated by the azimuth scale and micrometer corre-

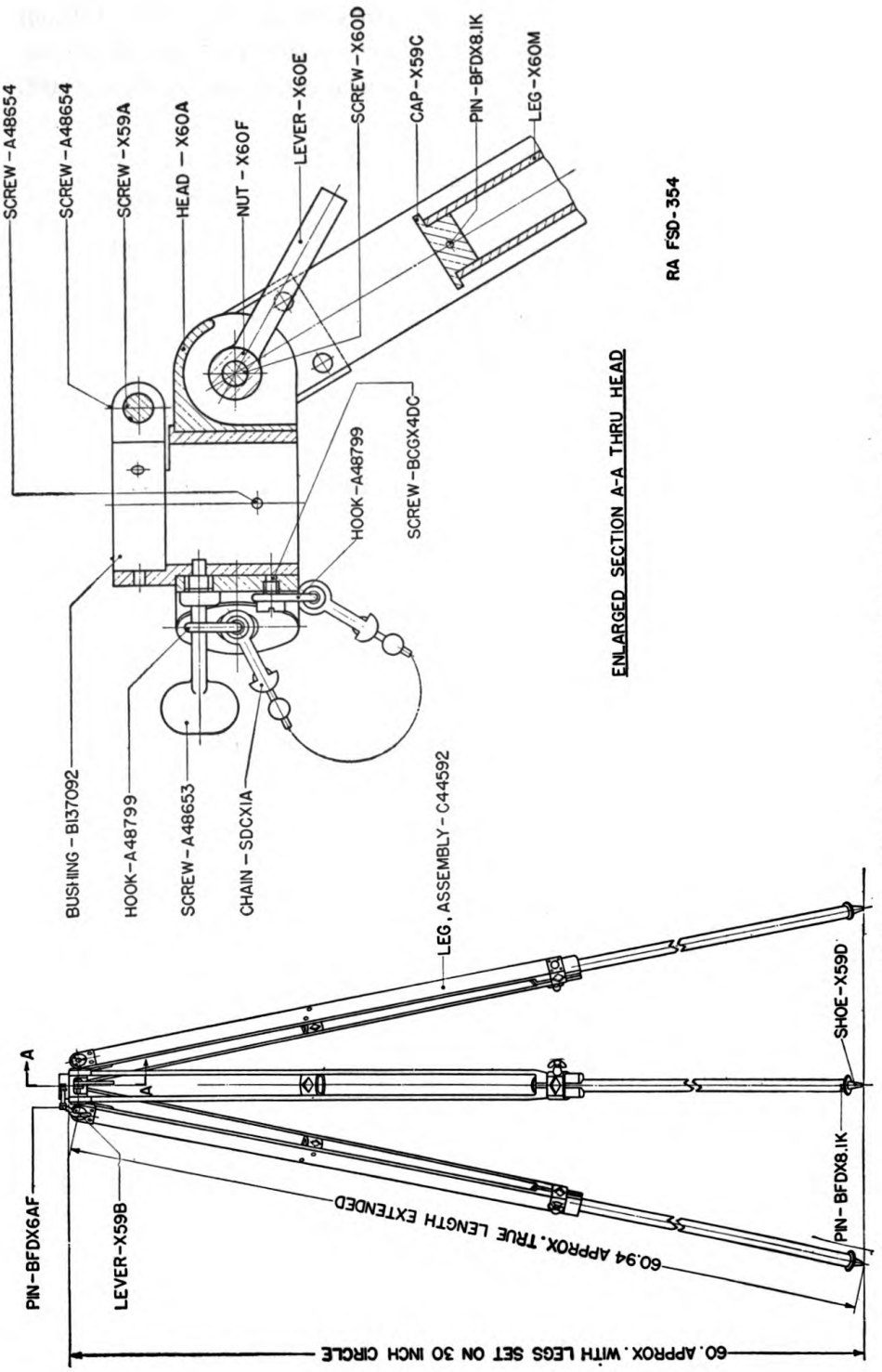



FIGURE 18.—Tripod, type G—assembled and sectioned views.

sponds to the azimuth angle of the line of sight. The instrument may be oriented by two methods, the method used depending on existing conditions.

(1) *By known azimuths.*—(*a*) Set the azimuth scale and micrometer to indicate the known azimuth of a selected datum point.

(*b*) Turn the aiming circle by means of the orienting mechanism, using either the orienting worm knob, X123C (sec. G–G, fig. 16), or the more rapid motion available with the wing nut, A39363, loosened, until the datum point appears on the vertical cross line of the reticle. Clamp the aiming circle by tightening the wing nut, A39363. Secure final accurate adjustment of the vertical line on the datum point by means of the orienting worm knob, X123C.

(2) *By magnetic bearings on magnetic north.*—(*a*) Set the azimuth scale and micrometer to indicate zero and rotate the declinator locking lever, A39325 (sec. C–C, fig. 14), so as to permit the magnetic needle to swing free.

(*b*) Turn the aiming circle by means of the orienting mechanism so that the arrow index lines of the declinator coincide approximately with the ends of the magnetic needle.

(*c*) Clamp the aiming circle by tightening the wing nut, A39363, then by means of the orienting worm knob, X123C, bring the south-seeking end of the magnetic needle to the center of the declinator mirror index, A39264, between the two parallel black lines. The readings of the azimuth scale and micrometer when so oriented will be magnetic azimuths.

*c. To determine angle of site.*—(1) *Method.*—Direct the telescope on the object and rotate the elevating worm knob to cause the object to appear on the horizontal line of the reticle, then rotate the angle of site worm knob to center the bubble in the angle of site level vial, A31308 (fig. 13). Read the angle of site scale and micrometer. This reading, less 300 mils, is the angle of site of the object.

(2) *Alternate method.*—Set the angle of site scale and micrometer to read 300 mils, and rotate the elevating worm knob to center the bubble in the angle of site level vial, A31308 (fig. 13). The angle of site of an object is then indicated by the graduations on the vertical line of the reticle, B129427. This method is applicable when the angle of site is less than 85 mils.

**16. Inspection.**—Inspection is for the purpose of ascertaining the condition of the instrument, whether repairs or adjustments are necessary to insure proper functioning and serviceability. The following list will serve as a guide:

| *Parts to be inspected* | *Points to be observed* |
|---|---|
| *a.* External part such as knobs, screws, etc. | *a.* Examine the instrument as a whole for loose and missing parts. Observe smoothness of operation of knobs. |
| *b.* Azimuth mechanism. | *b.* Rotate the knob of the azimuth mechanism throughout its full range in both directions. Observe any sticking or binding and backlash in the mechanism. |
| *c.* Elevating mechanism and angle of site mechanism. | *c.* Rotate the knob of the elevating and of the angle of site mechanism throughout its full range in both directions. Observe any sticking or binding and backlash in the mechanisms. |
| *d.* Circular level vial, A39669. | *d.* Center the bubble in the circular level vial, A39669. Rotate the instrument 360°. If the bubble does not remain central during the revolution an adjustment of the level vial is necessary. |
| *e.* Tubular level vial, A31308. | *e.* Examine the level vial. Note whether or not it is firmly set in its holder. |
| *f.* Magnetic needle, A39189. | *f.* The magnetic needle should swing freely on its pivot. There should be no evidence of any sticking or binding in its motion. |

**17. Maintenance and repair.**—*a. Adjustments.*—(1) *To test and adjust angle of site mechanism.*—The angle of site scale should indicate 3 and the angle of site micrometer, A39353 (sec. D–D, fig. 13), should indicate zero when the line of sight is horizontal. Read the angle of site of a distant point of known angle of site. If the value read does not agree with the known value, an adjustment is necessary. If the error is small, correction can be made by adjusting the angle of site micrometer. This may be done as follows: Loosen the micrometer retaining screw, A39254B. Rotate the micrometer until the required reading is indicated, then tighten the screw.

(2) *To adjust azimuth micrometer, A39349 (M1916) or A40314 (M1916MI).*—Loosen the azimuth micrometer retaining screw,

A38983B (sec. A–A, fig. 14). Rotate the azimuth micrometer until the micrometer reads zero then tighten the screw.

(3) *To adjust declinator to coincide with true direction of magnetic north.*—(*a*) Set up the aiming circle in a position that is not subject to local magnetic attraction and from which one or more points of known azimuth can be seen.

(*b*) Orient the instrument by magnetic bearings (par. 15*b*(2)).

(*c*) Measure the corresponding azimuth to each of the known points. Compute the difference between the known azimuths and the measured azimuths. The average of these differences will be the declinator calibration error. It should be zero if the declination mirror index, A39264 (sec. B–B, fig. 17), is in correct adjustment.

(4) *To adjust declinator mirror index, A39264.*—(*a*) Orient the instrument on magnetic north by the method of known azimuths (par. 15*b*(1)).

(*b*) Rotate the declinator lever, A39325, thus permitting the magnetic needle to swing free.

(*c*) Release the index holder clamping screw, BCUX1LE, and rotate the index holder adjusting screw, A39383 (sec. J–J, fig. 14), until the index coincides exactly with the end of the magnetic needle. Then tighten the screw, BCUX1LE. Check the adjustment after removing tools of magnetic material from the vicinity of the magnetic needle.

*b. Disassembly.*—(1) *To disassemble azimuth worm, B129428, of M1916 instrument.*—(*a*) Remove the micrometer, A39349, by removing the micrometer screw, A38983B. Remove the micrometer shoe, A39351 (sec. A–A, fig. 14).

(*b*) Remove the plunger compression spring, A39345 (sec. H–H, fig. 14), by removing the azimuth worm plunger plug, A39344.

(*c*) Remove the azimuth worm knob, A39343, by removing the taper pin.

(*d*) Loosen the headless flat screws, BCUX1LB and A39255B, and unscrew the ball cap, A39342.

(*e*) Withdraw the azimuth worm, B129428, with the ball socket, A39341, from the azimuth worm housing, D25577.

(2) *To disassemble azimuth worm, B129548, of M1916MI instrument.*—(*a*) Remove the azimuth knob, A40314 (sec. A–A, fig. 17), by removing the special screw, A38983B, from the worm shaft.

(*b*) Loosen the headless cone point screw, BCUX2KA, and remove the azimuth worm plunger cap, A40313.

(*c*) Remove the throw-out lever, A40315, by removing the two fillister head special screws, A40320.

(*d*) Remove the eccentric bushing stop, A39704, by removing the flat head screw, BCLX4BT.

(*e*) Withdraw the azimuth worm, B129548, with eccentric bushing, B129547, and associated parts from the azimuth worm housing, D25557. The disassembly can be carried out further if necessary.

(*f*) When reassembling, care should be exercised to fit the azimuth torsion spring, A40319, properly into the eccentric bushing and azimuth worm housing.

(3) *To disassemble elevating worm, A39358.*—(*a*) Remove the elevating knob, X123N (sec. E–E, fig. 13), by removing the taper pin from the worm shaft. Remove the six stop rings, A39382.

(*b*) Loosen the headless flat screw, BCUX1GA, and remove the elevating worm plug, A39380. Withdraw the elevating worm, A39358.

(4) *Removal of angle of site, level vial, A31308* (fig. 13).—Removal is accomplished by removing the three fillister head screws, BCGX4AB.

(5) *To disassemble angle of site worm, A39352.*—(*a*) Remove the angle of site knob, X123N (sec. D–D, fig. 13), by removing the taper pin from the worm shaft. Remove the six stop rings, A39382.

(*b*) Loosen the ring retaining screw, BCUX1GA, and remove the micrometer screw, A39254B. Remove the angle of site worm, A39352, and retaining ring, A39381, from the housing.

(6) *To disassemble declinator.*—Remove the retaining ring, A39386 (fig. 14), by unscrewing it from the declinator body, C44663. This permits access for disassembly of the magnetic needle, declinator circular level vial, and associated parts if necessary. When reassembling, check to see that the blue lacquered end of the magnetic needle points toward the north.

*c. Assembly.*—The procedure for reassembling is the same as for disassembling except in the reverse order. Adjust the ball caps of the orienting and azimuth worm shafts to no end shake with a minimum of friction. Lubricate the gears of the orienting, angle of site, elevating, and orienting mechanisms with grease, special, low temperature.

**18. Tools for maintenance and repair.**—For the tools incident to the maintenance and repair of the equipment see paragraph 8.

## SECTION V

# CARE AND PRESERVATION



**19. Care in handling.**—*a.* The aiming circles contain precision mechanisms and delicate optical parts and should therefore be handled gently to avoid unnecessary shocks.

*b.* Instruments that are temporarily out of use should be kept in the carrying cases provided.

*c.* Instruments should be protected from dampness as much as possible. After use in wet weather, the instruments should be wiped dry as soon as practicable. Instruments should not be placed in their cases when wet.

*d.* The magnetic needles should be lowered onto their pivots only when actually used in making observations.

*e.* When the instrument light is not being used, the flashlight cell should be removed from the battery tube and placed in the clip provided for that purpose. If this precaution is not taken, the deterioration of the cell may so damage the tube as to make it useless.

*f.* When disengaging the azimuth worm of the azimuth mechanism, care should be taken to disengage the worm sufficiently to prevent any possibility of scraping over the teeth on the worm gear. Any scraping over the teeth, even if only slight, will eventually damage the teeth, causing inaccurate readings.

**20. Optical parts.**—*a.* Lens tissue paper or a camel's-hair brush, free from grit or dust, should be used for cleaning optical glass surfaces. In using the lens tissue paper, the glass surface may be moistened by the breath and then cleaned with the paper. Hard rubbing should be avoided. To remove dust, brush lightly with the camel's-hair brush and rap the brush against a hard body to remove the dust which clings to the hairs.

*b.* To obtain satisfactory vision it is necessary that the exposed surfaces of the lenses and other optical parts be kept clean and dry. Corrosion and etching of the surface of the glass, which impair optical qualities of the instrument, can be prevented or greatly retarded by keeping the glass clean and dry.

*c.* Exercise particular care to keep optical parts free from oil or grease. Do not wipe the lenses with the fingers. To remove oil or grease from optical surfaces, apply ethyl alcohol with a clean camel's-

hair brush and rub gently with clean lens paper. If alcohol is not available, breathe heavily on the glass and wipe off with clean lens paper; repeat this operation several times until clean.

*d.* Polishing liquids, pastes, or abrasives should never be used for polishing lenses.

*e.* Moisture due to condensation may collect on the optical parts of the instrument when the temperature of the parts is lower than that of the surrounding air. This moisture, if not excessive, can be removed by the application of gentle warmth. Heat from strongly concentrated sources should never be applied directly, as it may cause unequal expansion of parts with resulting inaccuracies in observation.

**21. Lubrication.**—Interior moving parts of the aiming circles are lubricated with grease, special, low temperature, when assembled. Usually this greasing is sufficient lubrication to last between ordinary shop repair periods. If need of lubrication is evident upon inspection of the instrument, it should be disassembled and lubricated as directed in paragraph 7*b*, 12*b*, or 17*b*.

## APPENDIX

## LIST OF REFERENCES

**1. Standard Nomenclature Lists.**

Aiming circle, M1 ..... SNL F–160
Aiming circle, M1918 ..... SNL F–6
Aiming circle, M1916 and M1916MI ..... SNL F–107
Tripods (all active types) ..... SNL F–101
Current Standard Nomenclature Lists are as tabulated here. An up-to-date list of SNL's is maintained as the "Ordnance Publications for Supply Index" ..... (OPSI)

**2. Technical Manuals.**

Cleaning and preserving materials ..... TM 9–850
(now published as TR 1395–A)
Matériel inspection and repair ..... TM 9–1100
Instruction guide, aiming circle, M1 ..... TM 9–2530

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BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
*Chief of Staff.*

OFFICIAL:

E. S. ADAMS,
*Major General,*
*The Adjutant General.*

DISTRIBUTION:

B 6, 7 (3); R 6, 7 (5); IR 4 (5); IBn 9 (4); IC 9 (6).
(For explanation of symbols see FM 21–6.)



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